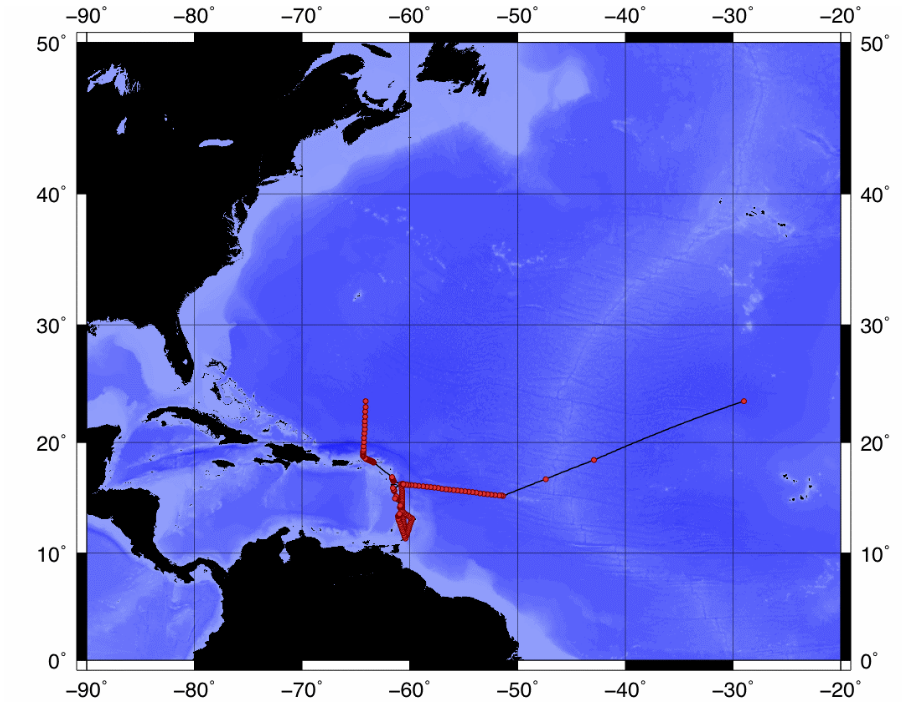
CRUISE REPORT: AR04
(Updated JAN 2013)



Highlights

Cruise Summary Information

WOCE Section Designation	**AR04**
Expedition designation (ExpoCodes)	**06MT20050813**
Chief Scientists	**Rhein, Monika, Prof. Dr. / IUPHB**
Dates	**2005 AUG 13 - 2005 SEP 19**
Ship	***RV METEOR***
Ports of call	Las Palmas (Spain) – Willemstad (Curacao)
Geographic Boundaries	23° 36.78' N 64° 20.04' W 28° 59.49' W 11° 21.7' N
Stations	181
Floats and drifters deployed	0
Moorings deployed or recovered	5 deployed / recovered

Contact Information:

Prof. Dr. Monika Rhein
Universität Bremen
Institut für Umweltphysik (IUP)
Abteilung Ozeanographie
Otto-Hahn-Allee
28359 Bremen, Germany

Tel: +49 (0)421 218 2408
Fax: +49 (0)421 218 7018
Email: mrhein@physik.uni-bremen.de

Links To Select Topics

Shaded sections are not relevant to this cruise or were not available when this report was compiled.

METEOR-Berichte 09-2

SUBFLUX

Cruise No. 66

August 12 – December 22, 2005, Las Palmas (Spain) – Talcahuano (Chile)

**Warner Brückmann, Monika Rhein, Gregor Rehder,
Jörg Bialas, Achim Kopf**

Editorial Assistance:

Andreas Krell
Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven

Leitstelle METEOR
Institut für Meereskunde der Universität Hamburg

2009

The METEOR-Berichte are published at irregular intervals. They are working papers for people who are occupied with the respective expedition and are intended as reports for the funding institutions. The opinions expressed in the METEOR-Berichte are only those of the authors. The reports can be obtained from:

Universität Hamburg
Zentrum für Meeres- und Klimaforschung
Institut für Meereskunde
Leitstelle METEOR/MERIAN
Bundesstr. 53
20146 Hamburg
Germany

The reports are available in PDF format from http://www.dfg-ozean.de/.
The METEOR expeditions are funded by the *Deutsche Forschungsgemeinschaft* and the *Bundesministerium für Bildung und Forschung*.

Addresses of the editors:

Dr. Warner Brückmann — Tel: +49 (0)431 600 2819
Leibniz-Institut für Meereswissenschaften — Fax: +49 (0)431 600 2916
IFM-GEOMAR — Email: wbrueckmann@ifm-geomar.de
Wischhofstr. 1-3
24148 Kiel
Germany

Prof. Dr. Monika Rhein — Tel: +49 (0)421 218 2408
Universität Bremen — Fax: +49 (0)421 218 7018
Institut für Umweltphysik (IUP) — Email: mrhein@physik.uni-bremen.de
Abteilung Ozeanographie
Otto-Hahn-Allee
28359 Bremen
Germany

Prof. Dr. Gregor Rehder — Tel: +49 (0)381 5197 336
Leibniz-Institut für Ostseeforschung — Fax: +49 (0)381 5197 302
Seestraße 15 — Email: gregor.rehder@io-warnemuende.de
18119 Rostock
Germany

Dr. Jörg Bialas — Tel: +49 (0)431 600-2329
Leibniz-Institut für Meereswissenschaften — Fax: +49 (0)431 600-2922
IFM-GEOMAR — Email: jbialas@ifm-geomar.de
Wischhofstr. 1-3
24148 Kiel
Germany

Prof. Dr. Achim Kopf — Tel: +49 (0)421 218 65800
MARUM — Fax: +49 (0)421 218 65805
Zentrum für Marine Umweltwissenschaften — Email: akopf@uni-bremen.de
Universität Bremen
Postfach 330 440
28334 Bremen
Germany

Citations:

Brückmann W, Rhein M, Rehder G, Bialas J, Kopf A (2009) (Eds) SUBFLUX, Cruise No. 66, August 12 - December 22, 2005. METEOR-Berichte 09-2, 158 pp, Universität Hamburg.

ISSN 0936-8957

METEOR-Berichte 09-2

SUBFLUX

Cruise No. 66

August 12 – December 22, 2005, Las Palmas (Spain) – Talcahuano (Chile)

**Warner Brückmann, Monika Rhein, Gregor Rehder,
Jörg Bialas, Achim Kopf**

Editorial Assistance:

Andreas Krell
Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven

Leitstelle METEOR
Institut für Meereskunde der Universität Hamburg

2009

Table of Contents **Page**

Table of Contents Part 1 (M66/1) **Page**

Table of Contents Part 2 (M66/2) **Page**

Table of Contents Part 3 (M66/3) **Page**

Table of Contents Part 4 (M66/4) **Page**

Abstract

The R/V METEOR M 66 cruise was carried out primarily in support of the "SFB" 574 (Volatiles and Fluids in Subduction Zones), a Cooperative Research Center dedicated to understanding the budget, reactions, and recycling of volatile elements in subduction zones and their role in climate forcing. To address the short- and long-term variability of the Earth's climate, the geochemical evolution of the hydrosphere and atmosphere, and related processes that are all connected to the return flow of volatiles and fluids from subduction zones, the SFB 574 is studying the Central American forearc off Costa Rica and Nicaragua (Fig 1).

The goals of the initial, oceanographic leg of cruise M 66 were to obtain part of a 2-year time series of the transport of southern hemispheric water through the passages into the Caribean, to study the circulation and variability of the flow in the deep western boundary current and in the interior of the basin, and to calculate time scales of deep water spreading from the Labrador Sea to 16°N.

Zusammenfassung

Die Reise M 66 von FS METEOR wurde in erster Linie zur Klärung von Fragestellungen des Sonderforschungsbereichs SFB 574 (Fluide und Volatile in Subduktionszonen) durchgeführt. Das Hauptziel des SFB 574 ist es, das Budget, die Reaktionen und die Rückführung volatiler Elemente in Subduktionszonen und ihre Wirkung auf das Klima zu verstehen. Für das Studium der kurz- und langfristigen Klimavariabilität, der geochemischen Evolution der Hydro- und Atmosphäre sowie verwandter Prozesse, die mit dem Recycling von Volatilen und Fluiden aus Subduktionszonen verbunden sind, fokussiert der SFB 574 seine Untersuchungen auf den zentralamerikanischen Kontinentalrand vor Costa Rica und Nicaragua (Abb. 1).

Das Ziel des ersten, ozeanographischen Fahrtabschnitts von M 66 war die Erhebung von Daten im Rahmen einer 2jährigen Zeitserie des Transports von Südhemisphären-Wassermassen durch Passagen in die Karibik, die Untersuchung der Wasserzirkulation und Variabilität im "Deep Western Boundary Current" und im Inneren des Beckens, sowie die Abschätzung von Zeitskalen der Tiefwasserausbreitung von der Labrador-See bis 16°N.

Research Objectives

SFB Objectives

The RV METEOR M66 cruise is of central importance to the "Sonderforschungsbereich 574". The multi-disciplinary analysis of the volatile phases (water, carbon, sulfur and halogens) and their complex effects on the exosphere is an ambitious task, and one of the highest priority objectives of today's geoscience.

Volatiles are mainly introduced into subduction zones via the sediments, the altered products of oceanic crust, and the trench fill from down-slope mass wasting. The output is via fluid venting at the deformation front, by gas hydrate formation/dissociation, and by volcanic degassing at the forearc. Inside the subduction zone the incoming material is transformed, mobilized or fractionated into different volatile reservoirs and phases. These phases are either ejected into the exosphere through the upper plate, accreted to the leading edge of the continental plate, or are transported into the lower mantle. The tectonic style of subduction, the structure of the margin wedge, and the properties and configuration of the downgoing plate all exert a first order control on volatile budget, its transformation, and return pathway.

The basic data acquisition for the investigations aboard RV METEOR was done by geophysical surveys, multibeam and side scan sonar surveys, sediment coring, water column sampling for methane, video-guided sea floor observations and lander deployments.

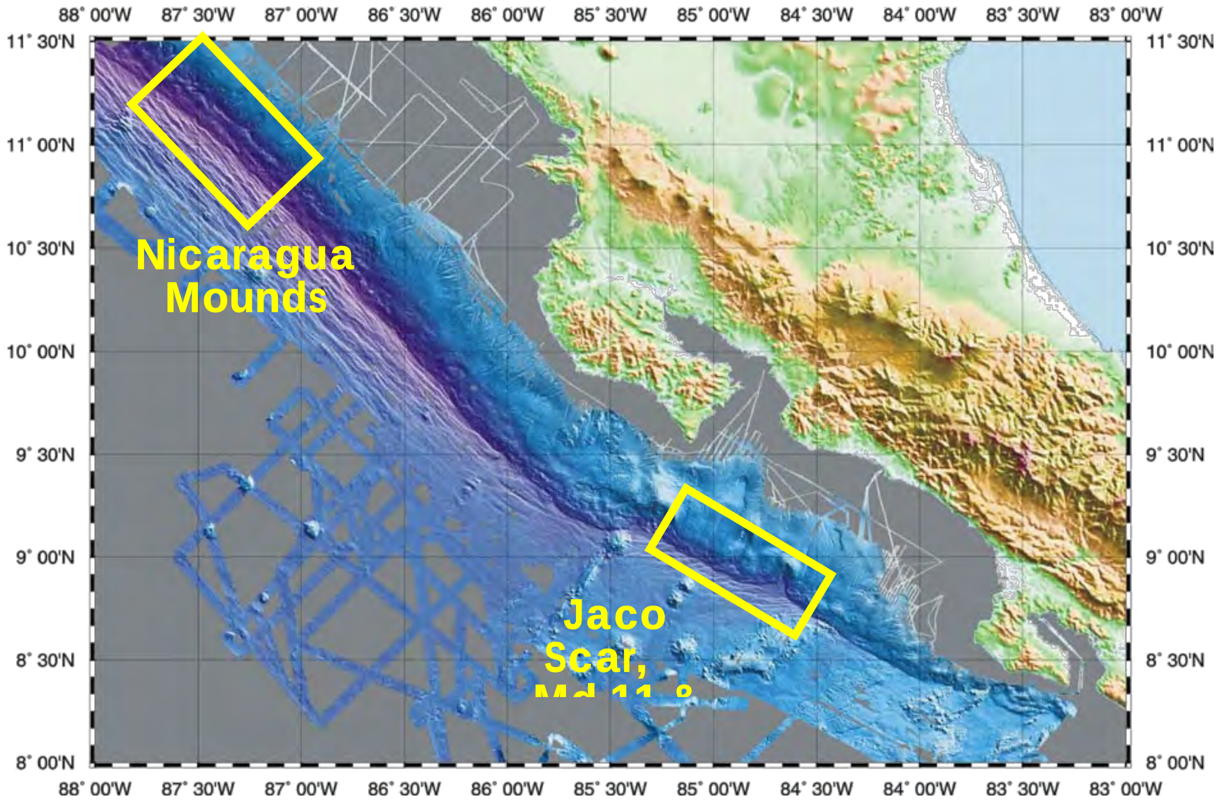


FIG. 1: General structure of the seafloor at the Costa Rica/ Nicaragua Pacific margin.

Objectives of Leg 1

The objectives of Leg 1 of M66 were unrelated to the SFB 574. It was an oceanographic leg focussing on upper ocean circulation. The goal was to obtain a 2-year time series of the transport of southern hemispheric water through the passages into the Caribbean. Further objectives were to determine the variability of the fraction of South Atlantic water east and north of the islands and to estimate the transport of southern hemispheric water east of the islands across 16°N.

With regard to deep circulation the goal was to study the circulation and variability of the flow in the deep western boundary current and in the interior of the basin and to calculate time scales of deep water spreading from the Labrador Sea to 16°N.

For this purpose, CTDO sensors were used to determine the distribution of water mass characteristics (pressure, temperature, salinity, oxygen) and analyses were performed to trace chlorofluorocarbon components CFC-11 and CFC-12 in water samples from 10L bottles. In addition, measurement of the velocity field were performed with ADCPs (Acoustic Doppler Current Profilers) attached to the CTDO system and with the vessel-mounted ADCPs (75kHz and 38.5kHz). A further objective was the recovery of the CARIBA mooring array instruments, i.e. acoustic current meters, T/S sensors and Inverted Echo Sounders (PIES) east of the Caribbean.

Objectives of Leg 2

Leg 2a was primarily dedicated to the transit to the working area off Central America. After the ship had passed the Panama Canal, a geophysically oriented program was carried out in the SFB574 working area off Costa Rica, with deployments of OBS/OBH stations and recovery of previously deployed stations.

The scientific program of Leg 2b comprised several detailed investigations of sites where active fluid venting occurs. The ROV Quest operated by the University of Bremen was used to sample and monitor mud extrusions, slides, and scarps generated by seamount subduction off Costa Rica and Nicaragua. The work complemented earlier work using standard and towed video-guided equipment. In addition, 2 different lander systems were deployed and several CTD/Rosette casts were performed to extend time series of the methane inventory at several stations and to quantify the inventory of the vent-derived methane at the shallow, very active Quepos Slide.

Objectives of Leg 3

The foremost objective of the work performed during Leg 3 was deep sampling of mud diapirs and carbonate mounds, large numbers of which have been found off Costa Rica and Nicaragua. These structures are considered to be a major element in the recycling of volatiles and fluids in this erosive continental margin – for this reason they are the focus of work for several subprojects of the SFB 574. Clear evidence has been found that fluids are transported upwards from deep sources as well as shallower sources.

Previous SFB work resulted in a differentiation between several types of authigenic carbonates: chemoherms and crusts associated with fluid expulsion at the sediment surface, gas hydrate – associated carbonates as well as limy and dolomitic concretions. Complete cores of all depths of these carbonate caps would enable a high-resolution temporal reconstruction of the devolatilisation history and fluid drainage. In addition, the pore water chemistry of the sediments can be expected to be less contaminated by sea water below the carbonate caps, as suggested by earlier samples from the marginal areas of mounds. This would allow for a better assessment of the source depth of fluids by geochemical and isotope geochemical methods, providing answers for one of the central SFB 574 objectives. Coring was performed by a portable drilling device, the BGS Seabed Rockdrill and Vibrocorer, which was deployed via METEOR's A frame.

Mound Culebra, Mound 10, Mounds 11 and 12 as well as a group of large mounds off Nicaragua discovered during SONNE cruise SO173 are already well known by preliminary SFB sampling using gravity corers and piston corers as well as OFOS surveys performed on cruises SONNE 163 and SONNE 173. For Leg 3a, representative profiles from the top of each structure as well as two further cores from the flanks were recovered in order to examine if potential earlier phases of stagnation during the formation of the mounds are documented within the carbonate layers.

Objectives of Leg 4

The major aim of Leg 4a was to understand the processes occurring in the other rise. To study the impact of outer rise faulting on the hydration of the oceanic crust approaching the Central American trench offshore Nicaragua two different techniques were used.

(i) a network of ocean bottom seismometers and hydrophones were left on the seafloor to record the natural seismicity in the outer rise area during leg M66/2a. The aim of this approach is to define active faults and the depth down to which they are active. This depth may provide an initial assessment of the depth down to which fluids can penetrate into the upper mantle.

(ii) active seismic wide-angle and refraction work was used to test the hypothesis that the mantle is hydrated or serpentinized. Typically, the upper mantle has velocities between 8.0 to 8.2 km/s. If the mantle is hydrated or serpentinized, seismic velocities are much lower. A serpentinization of 20 % would change the seismic velocities in the mantle to 7.6 km/s.

Furthermore, high resolution active seismic profiling was applied along three profiles to support deep-towed seismic streamer data analysing the structure and formation of mound structures along the continental margin. Cruise SO173-1 mapped a large number of mound locations by deep-towed sidescan and multichannel seismic streamer recordings. Seismic images of the structures indicate that they are related to faults or ridge-like tectonic features. A BSR has been mapped within the entire area of investigation with varying amplitude strength. Additional seismic data are to verify the variability of the BSR reflectivity and investigate the causes of BSR uplift or disappearance underneath the various mound structures and the relation to the tectonic setting.

Leg 4b was entirely dedicated to testing a new CPT (cone penetration testing) free fall lance. The overall objective when studying active convergent margins is to unravel the complex fluid processes and their ramifications for natural hazards such as submarine landslides and earthquakes. The understanding of such processes may be severely deepened if the crucial controlling parameters are measured in situ. For that purpose, a free fall CPT lance has been built. This device allows a time- and cost-effective characterization of both pore pressure and sediment strength in the uppermost ocean floor sediments. CPT measurements are usually carried out with a cylindrical lance, either motor-driven or as a free fall instrument. Penetration depth is controlled by sediment composition/grain size as well as the weight of the lance. In our case, it is a few meters. During penetration, frictional forces at the tip and along the sleeve of the lance are measured. The amount of frictional resistance allows for a classification of the sediment. In addition to these first order strength measurements, a piezometric cell is measuring pore pressure in the sediment.

Meteor-Berichte 09-2

SUBFLUX

PART 1

Meridional Overturning in the subtropical Atlantic

Cruise No. 66, Leg 1

August 12 – September 19, 2005, Las Palmas (Spain) – Willemstad (Curacao)

Monika Rhein, Jan Aschmann, Oliver Bislich, Ramon Brentführer, Klaus Bulsiewicz, Reinhard Drews, Sandra Erdmann, Gerhard Fraas, Karin Fraas, Jann Grahlmann, Thor Hansteen, Kerstin Kirchner, Andreas Klügel, Christian Kreutzmann, Jon-Olaf Krisponeit, Anna Ksienzyk, Xin Li, Christian Mertens, Michael Oschmann, Reiner Steinfeldt, Uwe Stöber, Maren Walter, Torsten Truscheit, Gesa Voehrs

Editorial Assistance:

Andreas Krell
Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven

Leitstelle METEOR
Institut für Meereskunde der Universität Hamburg

2009

Table of Contents Part 1 (M66/1) Page

1.1 Participants

Name	Discipline	Institution
1 . Rhein, Monika, Prof. Dr.	Chief scientist	IUPHB
2 . Bulsiewicz, Klaus	CFC-analysis	IUPHB
3 . Fraas, Gerhard	Moorings	IUPHB
4 . Fraas, Karin	CTD/ADCP watch	IUPHB
5 . Voehrs, Gesa	CTD/ADCP watch, dust sampling	IUPHB
6 . Erdmann, Sandra	CFC-watch	IUPHB
7 . Bislich, Oliver	CTD/ADCP watch	IUPHB
8. Kirchner, Kerstin	CTD/ADCP	IUPHB
9 . Krisponeit, Jon-Olaf	CTD/ADCP watch	IUPHB
10. Aschmann, Jan	CTD/ADCP watch	IUPHB
11. Kreutzmann, Christian	Meteorology	DWD
12. Mertens, Christian, Dr.	vm-ACPs,moorings	IUPHB
13. Drews, Reinhard	CFC watch	IUPHB
14. Oschmann, Michael	oxygen analysis, dust sampling	IUPHB
15. Grahlmann, Jann	CTD/ADCP watch, dust sampl.	IUPHB
16. Steinfeldt, Reiner, Dr.	CTD/Salinometer	IUPHB
17. Walter, Maren, Dr.	LADCP	IUPHB
18. Li, Xin	CTD/ADCP watch	IUPHB
19. Brentführer, Ramon	LADCP	IFM-GEOMAR
20. Stöber, Uwe	CTD/ADCP watch	IUPHB
20. Torsten Truscheit	Meteorology	DWD
*21. Klügel, Andreas, Dr.	Geology	IFM-GEOMAR
*22. Ksienzyk, Anna	Geology	IFM-GEOMAR
*23. Hansteen, Thor, Dr.	Geology	IFM-GEOMAR

*participants from August, 12. to 15. 2005.

IUPHB Universität Bremen, Institut für Umweltphysik, Abt. Ozeanographie, Otto-Hahn-Allee, NW1, 28359 Bremen, Germany

DWD Deutscher Wetterdienst, Geschäftsfeld Seeschifffahrt, Bernhard-Nocht-Str. 76, 20359 Hamburg, Germany

IFM-GEOMAR Leibniz Institut für Meeresforschung, Wischhofstrasse, 24105 Kiel, Germany

1.2 Research Program

The warm branch of the Atlantic meridional overturning circulation is important for the role of the North Atlantic in European climate and climate change. Yet, no time series has been made so far of the transport of southern hemispheric water after crossing the Atlantic. In this project, we have obtained a 2-year time series of the transport of southern hemispheric water through the passages into the Caribbean and determined the variability of the fraction of South Atlantic water east and north of the islands. Moreover we have estimated the transport of southern hemispheric water east of the islands across 16°N. The deep circulation encompasses the major part of the cold path of the overturning circulation. We have studied the circulation and variability of the flow in the deep western boundary current and in the interior of the basin and calculated time scales of deep water spreading from the Labrador Sea to 16°N.

CTDO sensors were applied to determine the distribution of water mass characteristics (pressure, temperature, salinity, oxygen), and water samples from 10-L bottles were analyzed for the chlorofluorocarbon components CFC-11 and CFC-12. The velocity field was measured with ADCPs (Acoustic Doppler Current Profilers) attached to the CTDO system and with the vessel-mounted ADCPs (75kHz and 38.5kHz). The Bremen mooring array CARIBA, which had been deployed east of the Caribbean equipped with acoustic current meters, T/S sensors and Inverted Echo Sounders (PIES), was recovered. The moored time series was combined with the shipboard measurements.

The data set complemented by our measurements from recent years and by historical data allows estimating the strength and the pathways of the warm path of the Atlantic meridional overturning at the inflow into the Caribbean between the Windward Islands and east of the Islands across 16°N in the western Atlantic.

1.3 Narrative of the cruise

RV METEOR departed on August 13, 9 UTC from Las Palmas and headed towards the Henry Seamount at 27°18.5’N, 17°47.0’W. Dredging began at August 14, 1 UTC, and ended at August 15, 1 UTC. The weather was favourable for dredging in the southern section of the seamount. The METEOR reached Hierro at August 15, 6:30 UTC, and the three geologists and one technician departed while METEOR stayed near Puerto de la Estaca.

At August 15, 7:30 UTC, the METEOR headed towards the easternmost CTD station (51°W) of the 16°N section. With the trade winds from the back the speed of the METEOR was around 12 kn most of the time. During the transit of about 2000nm, a CTD test station was carried out successfully at August 17, 15:30 UTC. The CTD was lowered to 2000m depth. At August 20, 16 UTC, the 22 Niskin bottles were tested for CFC contamination by closing them all in the CFC minimum zone at 2500m depth. In the eastern Atlantic, very small concentrations are expected at this depth level. The test was successful, all bottles closed and no contamination could be found. This result was supported by the oxygen analysis. A second test was done on August 21, 17 UTC.

The 16°N section began at August 22, 15 UTC at the flank of the Midatalantic Ridge (CTD 4, 15°15’N, 51°20’W) at a water depth of 4000m. In order to resolve the flow-field of the Antarctic Bottom Water (AABW) at the bottom of the flank, the station spacing was at first 10nm, and then increasing to 20nm. The chosen spatial distance allows the resolution of the flow field with the LADCP profiles measured parallel to the CTD casts. The LADCP profiles had good quality throughout the water column, but the expected northward flow of the AABW was not observed. The subsequent stations also showed the tidal velocities in the order of 3-4cm/s. The weather and sea remained calm and provided excellent working conditions. In the early morning (5UTC) of August, 25 the METEOR reached the longitude of 55°W, which on former cruises was the boundary between a net southward flow of North Atlantic Deep Water west of 55°W and a more sluggish and uncoordinated flow east of that longitude. Between 55°30’W and 57°40’W (Aug 25, 11UTC – Aug 26, 20UTC) we encountered an eddy. These eddies are called NBC rings, because of their creation at the retroflection of the North Brasil Current (NBC) into the North Equatorial Counter Current off the coast of Brazil. These rings are crucial for the transport of water from the South Atlantic across 16°N. The ring was subsurface intensified with highest velocities of 25-35cm/s between 400m and 600m depth, the fraction of South Atlantic water (SAW) was higher than 70% in the intermediate and central water masses. The signal at the surface was weak, so that most likely the ring cannot be seen by remote sensing.

During CTD 27 on August 27, one of the LADCP workhorses from RD Instruments (San Diego) failed, so that unfortunately we were unable to measure the deep velocity distribution in the western boundary region, where we expected the strongest signals. This instrument was sent to RD Instruments (RDI, San Diego) for refurbishment in February 2005. It failed after 20 profiles in June 2005 during our cruise with N/O Thalassa . The instrument was then sent back to RDI at July, 12 and after repair was delivered to RV METEOR to Las Palmas. Presumably, the instrument was not properly repaired. Due to the many parallel research cruises we were unable to take a backup instrument with us. For the remaining work in the deep western boundary current no deep velocity measurements could be carried out. With one instrument remaining, only velocity profiles to water depths shallower than 3000m are possible.

The 16°N section was finished with CTD 38 at August, 29, 4:30UTC. The METEOR headed south to carry out CTD stations every 9nm on the way to the mooring position B10 east of Saint Lucia and then to B8 north of Tobago. B10 was reached at August 30, 12 UTC (CTD 54), and B8 at September 1, 2UTC. Near that position, the surface water was murky and down to about 5m very fresh with salinities of about 27.0. Both features indicated the presence of river outflow from the Amazon and/or Orinoco. Although low salinities are frequently observed in that area especially a few months after the maximum of the river outflow, they are usually not below 32.

The METEOR turned towards Barbados, i.e. to the position of mooring B9 on the western side of Barbados. After finishing the CTD section, the remaining time was used to repeat the northern part of the section from Tobago to Barbados down to 12°35’N, 60°0’W with the two vessel mounted ADCPs. In the early morning of September, 2 (9:40UTC), CARIBA mooring B9 was released. 7 minutes after release the top float was seen and at 11 UTC the mooring was completely recovered. The top element, moored in 70m depth, showed severe signs of fishing activities but fortunately was not lost.

The CTD section from Barbados to St. Lucia began at September 2, 11:50 UTC, the station spacing was like on the last section about 9nm. When finished, a transport section to 13°40.0’N, 60°30.0’W was carried out. At September 3, 8:34 UTC the PIES at 13°47.50’N, 60°41.82’W was released. The instrument didn’t respond. The release-code was repeatedly sent, but no acoustic nor radio or visual (flashlight) signals were received, although the flashlight should be easily seen in the darkness. Most likely, the PIES was not released. The search was interrupted at

10:25 UTC. CARIBA mooring B10 at 13°48.00’N, 60°41.50’W was released. Both releasers responded immediately, and the mooring was sighted 7 minutes later. The complete mooring was on board about at 11:30 UTC. This mooring showed also signs of fishing activities. The construction of the top float was damaged and the mooring contained several pieces of fishing gear. It turned out that a few months after deployment, the mooring had been hauled several 100m nearer to the shore, where the bottom was 30m shallower. The top float was then located in 35m depth instead of 70m.

Afterwards the search for the PIES was continued. Several items were found, but not the PIES. The search was abandoned at 12:20 UTC, and the METEOR headed towards Tobago. Early at September 4, 7:15 UTC the PIES was contacted and after several attempts the releaser worked at 8:45 and the PIES surfaced. It was dark, the flashlight of the PIES made it very easy to find the instrument at 9:20. After the PIES was brought on board (9:30), CARIBA mooring B8 was released at 9:35, detected at 9:40 and recovered completely. The releasers were on deck at 10:50. At the former mooring position B8 a CTD (CTD 91) was carried out at 11:30 UTC.

This (CTD 91) was the first station on the way to St. Vincent, the station spacing was 10.5nm. The section was finished with CTD 102 at September 5, 12 UTC. After 11nm, the work in the passage between St. Vincent and St. Lucia began. The CTD section (CTD 103-108) was complemented by several ADCP transects to study the influence of the tides on the velocity distribution. The vessel mounted ADCP reached down to the bottom so that we received velocity data in the passage with full continuous coverage. After finishing the passage work, the METEOR was on her way to 13°47.50’N 60°41.80’W, the PIES position off St. Lucia. The METEOR drifted towards the PIES, and the instrument was acoustically released. It took about an hour from September 6, 6 UTC to 7 UTC before the PIES responded, and the instrument surfaced 30minutes later. The PIES was brought on deck at 7:54 UTC. Both PIES carried out the measurements successfully.

The METEOR continued her track to the passage between St. Lucia and Martinique. After 5 CTD stations (CTD 109-113), the 12nm wide passage was also studied with several shipboard ADCP transects. The METEOR left the passage at September 6, 20 UTC and sailed leewards of Martinique to the passage between Martinique and Dominica. Unfortunately Dominica refused the research within the 3nm zone, so that we could not achieve full coverage of the passage. The work in the passage was finished at September 7, 15 UTC. In order to reach deeper well mixed water needed to calibrate the moored MicroCats with the CTD, a CTD station was carried out in the Caribbean at 15°N, 61°23’W with a water depth of 2356m at 17UTC. Only 4 10L bottles were attached at the carousel, the others were replaced by the MicroCats.

Work continued when the passage between Dominica and Guadeloupe was reached at Sep. 7, 23 UTC with CTD stations (CTD 121-125) followed by ADCP transects. The 3nm zone of Dominica has been left out. At September 8, 13 UTC the METEOR stopped near Pointe a Pitre (Guadeloupe) to obtain the replacement for the leaking ADCP workhorse. The Leibniz Institute for Marine Research in Kiel, Germany was able to provide us with an instrument with short notice. The instrument was brought at 11:30 UTC and the METEOR set course to the 16°N section to repeat the stations in the Deep Western Boundary Current with 2 ADCP workhorses attached to the CTD/carousel. The station work started at 19 UTC and was finished at September 9, 13 UTC. In order to study deep mixing in the western boundary current, a CTD/LADCP YoYo station was carried out at 16°17’N, 60°35’W which lasted for 12 hours and 6 complete profiles

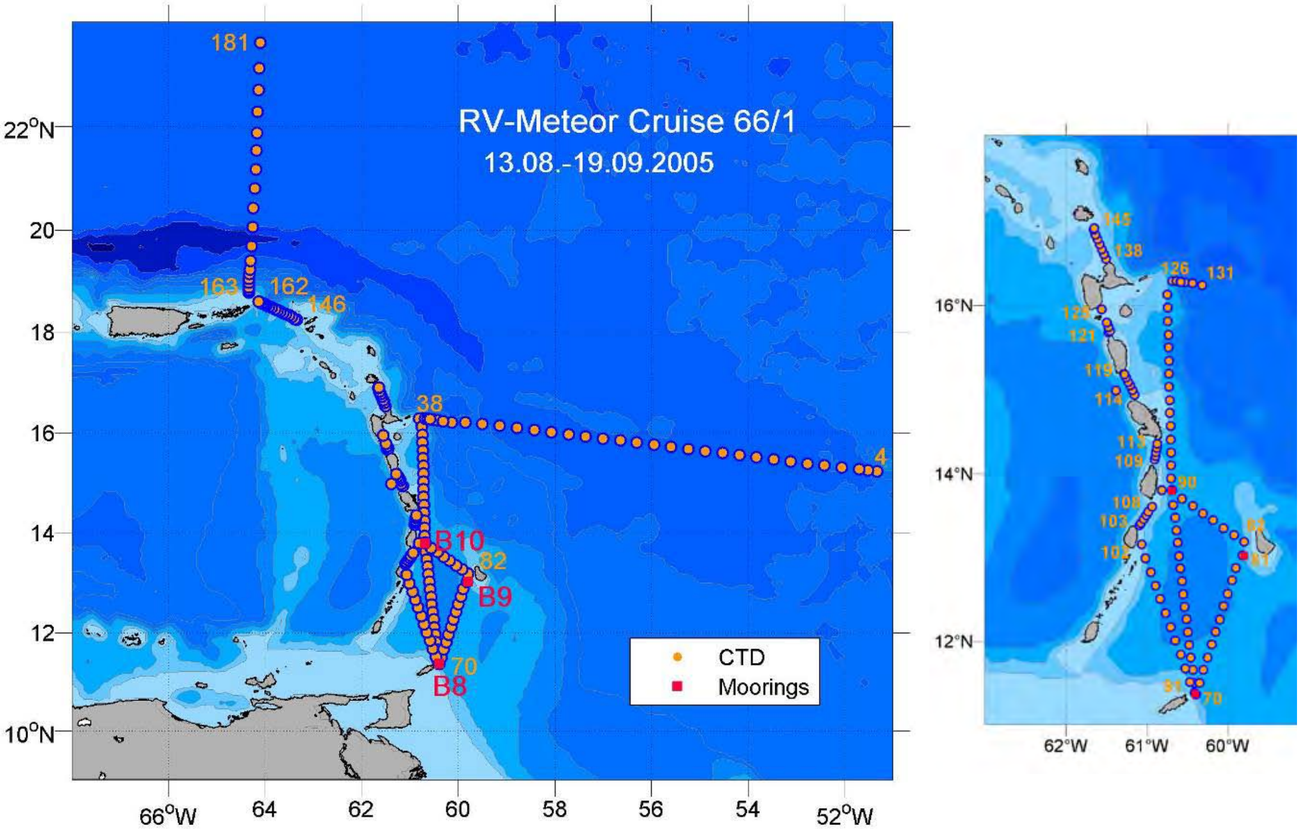


FIG. 1.1: Stations between Tobago and Antigua, METEOR cruise M66/1.

(CTD 132-137) could be taken in that time period. The results will be compared to microstructure measurements of K. Polzin, Woods Hole, USA, taken at about the same position.

Whether water from the South Atlantic also flows through the passages north of Guadeloupe was studied with CTD stations and ADCP transects in the passage between Guadeloupe and Antigua as well as between Anguilla and Anegada (Sombrero Passage) The latter is more than 2000m deep. The measurements in the Guadeloupe-Antigua passage (CTD 138-145) were finished at September 10, 21 UTC. The water between the two passages is very shallow, so that only ADCP sections were carried out. The work in the Sombrero Passage lasted from September 11, 9 UTC to September 12, 17:30 UTC (CTD 146 – 162). No CFC data have been taken in the Sombrero Passage. Several valves of the analysis system failed and through the unusual high failure rate the CFC sampling was stopped to be able to cover the following deep western boundary section. The velocity field in the passage was strongly influenced by tides. The detided total transport through the relatively large Sombrero Passage was small with 0.9 Sv inflow.

At September 12, 19 UTC, the CTD 163 marked the beginning of the meridional boundary section from Anegada across the Puerto Rico Trench to 23°N, 64°W. The measurements stopped at 5700m depth, although the trench is much deeper. The station spacing was at the slope 2.5 – 5nm, and further offshore the distance increased to 22nm. The deep water was devoid of scatterers leaving not enough signals for the LADCPs. The two instruments were removed after reaching water deeper than 5200m.

The last station of the boundary section at 23°36’N 64°06’W (CTD 181) was finished on September 16, 11:30 UTC, Shortly before the CTD was back on board, the CFC analysis system had to be shut down because of problems in the gas supply line, and the CFC samples were taken ‘offline’. The glass ampoules were flame sealed and will be analysed in our lab in Bremen.

The METEOR set course to Curacao, where we arrived at September 19, 11 UTC. During the entire cruise, the METEOR always experienced weather and sea conditions suitable for work.

1.4 Preliminary Results

1.4.1 CTD-O_2 Measurements

(R. Steinfeldt)

Measurements of conductivity, temperature, pressure and dissolved oxygen were performed with a Sea-Bird 911 plus system. The CTD was operated on a water sampler carousel together with 22 10 l Niskin bottles and 2 LADCPs. CTD data quality was good throughout the whole cruise. Some of the Niskin bottles, however, showed leakages at the bottom or the outlet. CTD data were calibrated by minimizing the difference between CTD values and salinity and oxygen samples from the Niskin bottles measured on board. The number of direct measurements was 1047 for oxygen and 498 for salinity, i.e about 6 and 3 samples per profile.

Oxygen measurements were carried out by the Winkler titration method. The standard did not show a remarkable drift, and the mean standard deviation between double samples was 0.020 ml/l. The difference between the directly measured and calibrated CTD oxygen data is 0.048 ml/l (0.046 ml/l) for all (below 1000 dbar) samples. At the beginning, the CTD oxygen sensor showed temporal fluctuations, but from profile 13 on identical calibration coefficients were used.

Salinities of the water samples were determined by means of a Guildline Autosal salinometer of type 8400A. The rms differences between the measured and calibrated CTD values amounted to 0.0029 (0.0024) for all (below 1000 dbar) samples. The mean deviation between measurements of substandard was in the range of 0.001.

IAPSO Standard Seawater of batch 145 was used for calibrating the salinometer. The salinities in the Antarctic Bottom Water (AABW) are in good agreement with former cruises if an offset of 0.003 is subtracted as was also done for salinity calibrations with batch 141.

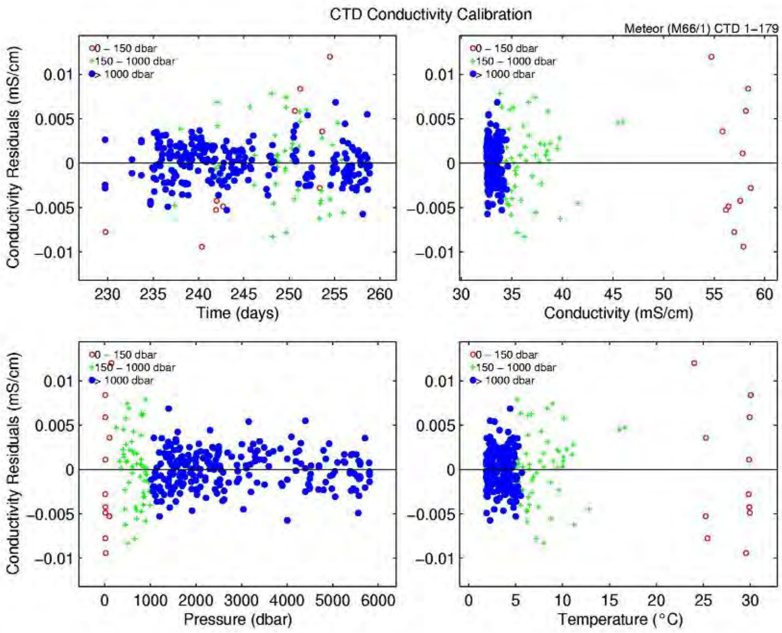


FIG. 1.2: Calibration of the conductivity sensor.

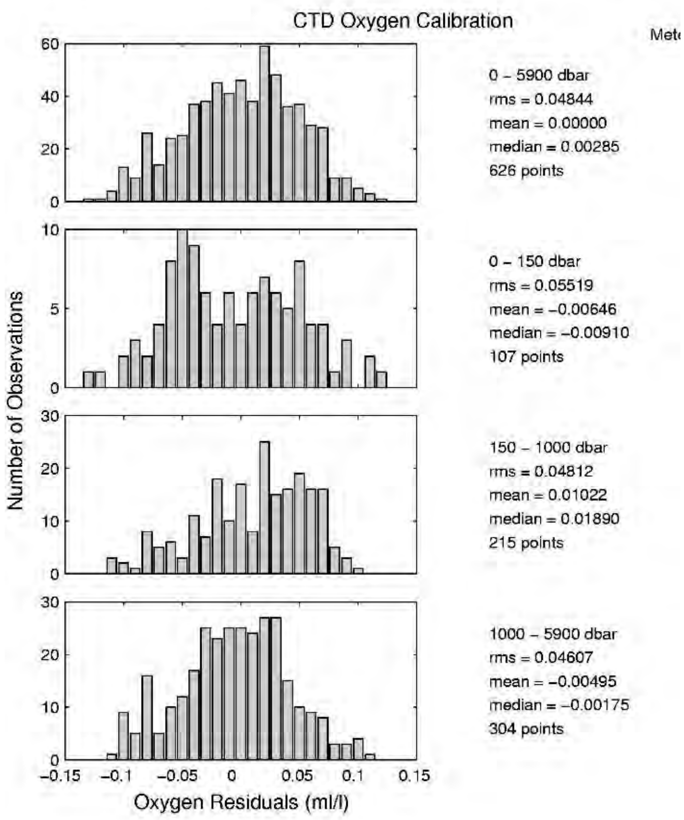


FIG. 1.3: Calibration of the oxygen sensor.

The oxygen values in the deep water are low compared with older data (differences between 0.05 and 0.1 ml/l). The surface oxygen saturation, on the other hand, is about 104 % and thereby in the same range as was measured the years before. An anomal large amount of samples (about one third) could not be used for the calibration routine both for oxygen and salinity, as the difference against the CTD values was too large. One reason could be the leakage of some of the Niskin bottles and/or problems at the oxygen sampling.

1.4.2 Analysis of Chlorofluorocarbons

(K. Bulsiewicz)

During cruise M66/1 water samples have been collected from 10l Niskin bottles for the analysis of the chlorofluorocarbons CFC-11 and CFC-12. Measurements of the CFC concentration in the water samples have been performed on board using a gas chromatographic system with capillary column and Electron Capture Detector (ECD). CFC sampling has been performed on 125 stations. A total of 1300 CFC data have been obtained.

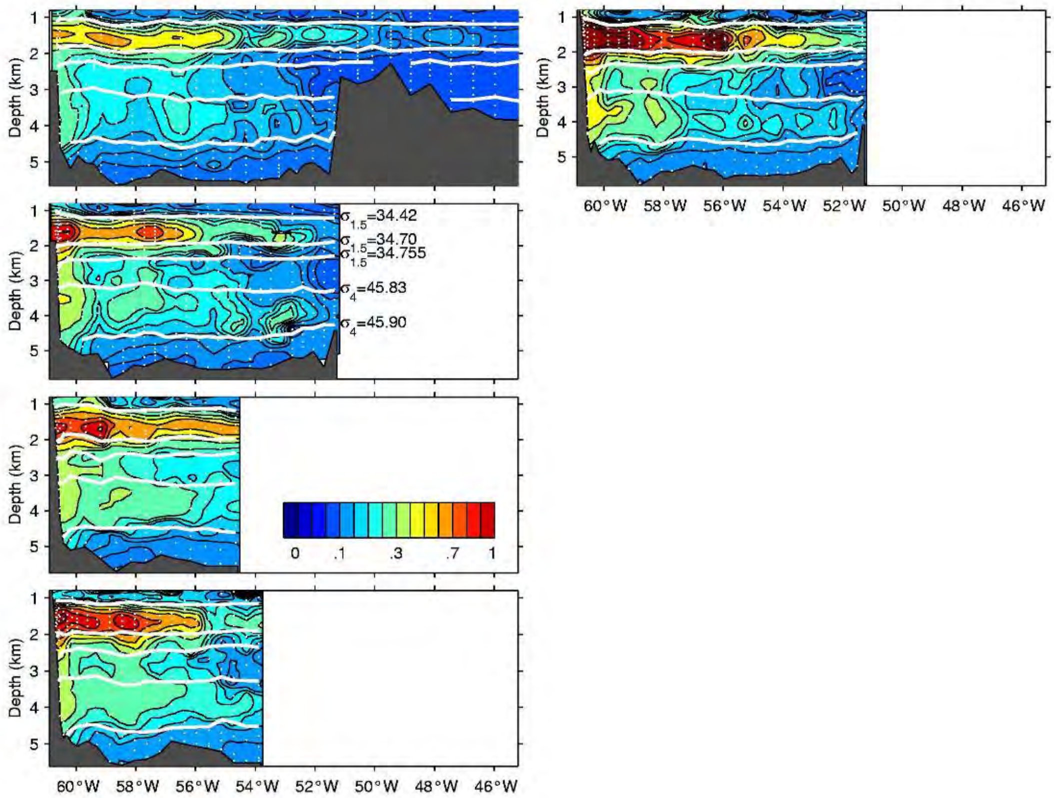


FIG. 1.4: CFC-11 distribution at 16°N, 2000 – 2005. Distributions 2000-20004 published in Rhein et al., 2004. Left column from top to bottom: 2000 – 2004; right column: 2005.

On the last station, CFC samples were sealed in glass ampoules for later measurements on land, as the remaining amount of pure nitrogen was not sufficient to run the automatic extraction system.

The sampling blank for CFC-11 and CFC-12 was estimated at a test station where all bottles were tripped at the same depth. This water is 'old', exhibiting zero CFC-concentrations. For CFC-11 and CFC-12 the resulting sampling blank was 0.005 pmol/kg. Accuracy was checked by analysing 33 water samples at least twice. It was found to be 0.6% for CFC-11 and 0.4% for CFC-12. The CFC concentration of the gas standard used to calibrate the water samples are reported on the SIO98 scale.

1.4.3 Lowered Acoustic Doppler Current Profiler LADCP
(M.Walter)

Most of the hydrographic stations were accompanied by current measurements with a lowered acoustic Doppler current profiler (LADCP) system attached to the CTD and water sampling carousel. Throughout the cruise, three instruments (RDI 300 kHz Workhorse Monitor) were used, partly two together or one as a single instrument.

Two instruments were used in a synchronized Master-and-Slave mode, with the upward looking as Slave and the downward looking as Master. When only one instrument was used, it was mounted downward looking. The instruments were powered by an external battery supply, consisting of 35 commercial quality 1.5V batteries assembled in a pressure resistant Aanderaa housing. The system was set to a ping rate of 1 ping/s and a bin length (= vertical resolution) of

10 m with a nominal range of 200 m for both operating modes, Master-and-Slave as well as single.

In total, 160 LADCP profiles were obtained during the 181 CTD stations of the cruise. The profiles from 132 to 137 were taken at the same position as a time series station.

During profile 26 on the 16° N transect, a water leakage (probably through the transducers) occurred in the upward looking instrument. Two of the transducers were damaged and severe corrosion was evident on one of the electronic boards of the unit. Unfortunately, there was no backup instrument on the ship at the time. With a water depth greater than 5000 m and very clear water (= few backscatterer), the data from a single instrument were not sufficient for a good-quality profile. Thus, the ensuing profiles up to CTD cast 33 were done without an ADCP. From cast 34 onwards, in the shallower and more productive waters close to the Antilles, a single instrument was used for profiling. A backup instrument shipped to Guadeloupe from the IFM-GEOMAR was available from profile 126 onwards, and was used for the rest of the cruise as a Slave.

From profile 114 onwards, beam 1 of the downward looking instrument started switching on and off. When the beam was working, it worked fine (normal range etc, no signs of any problem), but it stopped working for large stretches of time (several minutes) during profiles.

The problem occurred mainly in shallow water, and we suspect an electronic connection problem related to outside pressure. After profile 117, the instrument was dismounted and checked for leakage, but everything was fine (except the occasional beam failure), therefore the instrument was remounted for profile 119 and used for the rest of the cruise. 3-beam solutions were used for the velocity calculation for the periods where beam 1 failed.

The stations from 169 up to the end of the cruise (a transect across the Puerto Rico Trench) were again deeper than 5000 m and extremely scarce in backscatterers for depth greater than 2000 m, so that even the range of the combined instruments was to small to obtain velocity profiles.

The different types of environments lead to large differences in instrument range during the cruise. For the shallower (up to 2500 m water depth) stations close to the Antilles and in the passages, there was a vast amount of backscatterers, and the range of the instrument (Master only) was up to the nominal 200 m in the upper 1000 m, and scarcely falling below 60 m (again for the single instrument). With lowering and heaving velocities between 0.8 and 1.2 m/s of the instrument package this resulted in at least 200 shear estimates per depth bin and very good quality profiles.

In the deep stations of the 16°N and the Puerto Rico Trench sections, there were virtually no backscatterers below 2000 m, and the range was reduced to 2 bins (20 -30 m) for each instrument (50 m total for the package) in those parts of the profiles. With less than 100 shear estimates per depth bin no reliable velocity profile was obtained.

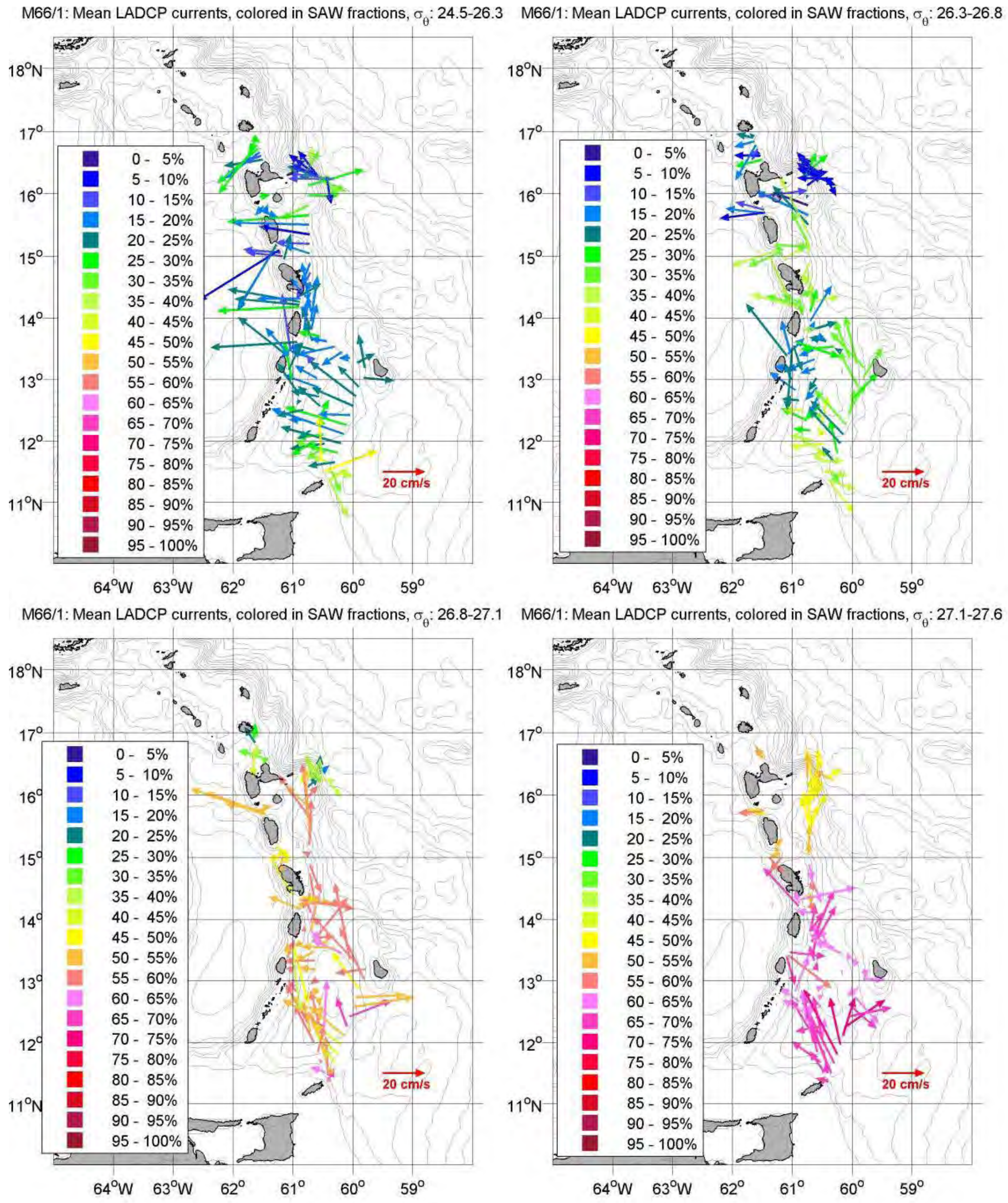


FIG. 1.5: Velocity distribution from LADCP measurements in the passages between Tobago and Guadeloupe for the water masses as defined in Rhein et al., 2005. The colour denotes the fraction of South Atlantic Water. The vertical and horizontal distribution of the SAW fractions in all passages measured during M66/1 are presented in Fig.1.6.

Post processing of the raw data was done using an inverse method which incorporates the measured velocity shear, the surface drift of the ship during the cast, and the bottom track velocities measured by the downward looking instrument to produce profiles of velocity and shear. This resulted in high quality velocity profiles, even for profiles with very weak current velocities (<0.05 m/s) and zero mean. Larger errors occur in the profiles deeper than 4000 m with few backscatterers and weak velocities, where not enough information is available for a good inversion.

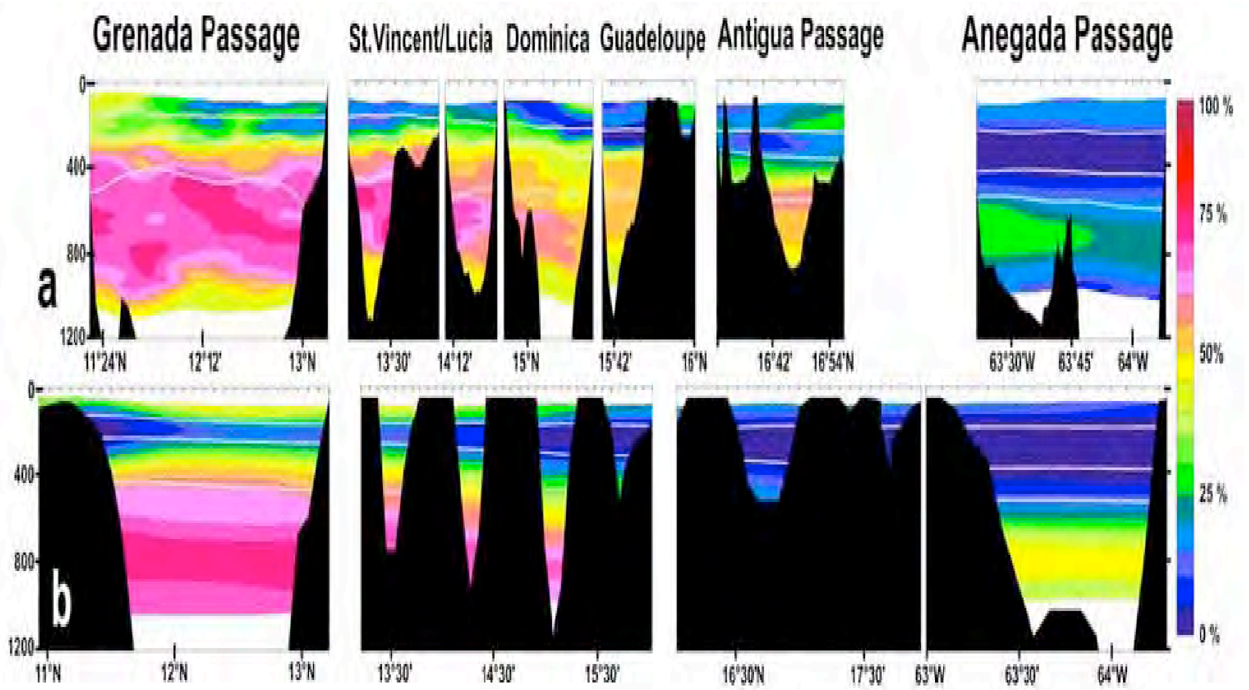


FIG. 1.6: *a)* Distribution of the SAW fraction in the passages. b) the mean SAW distribution in the FLAME model. The passage width is shown proportional except for Anegada Passage (twice as wide). The topography is derived from echosounder data (a) or the model grid (b). Fig. from Kirchner et al., 2008.

1.4.4 Shipboard Acoustic Doppler Current Profiler SADCP

(C. Mertens)

Simultaneous single-ping data were recorded from two RD Instruments Acoustic Dopplers current profilers: A 75 kHz and a 38 kHz Ocean Surveyor (OS) model, both with flat phased-array transducers. The 75 kHz OS was mounted into the hull of the ship in July 2004, and the 38 kHz instrument was lowered in the ship's well at the beginning of the cruise.

Both instruments were configured to collect narrow bandwidth water-profile data throughout the cruise. The data from the 75 kHz OS was recorded in 8 m bins to get high vertical resolution data in the upper water column. To achieve maximum range the 38 kHz OS data were collected in 32 m bins. Both systems operated flawless throughout the cruise. The ship's 78 kHz Doppler log is known to cause strong interference with the 75 kHz Ocean Surveyor which results in a reduced range of about 250 m and a deterioration of the data quality. During station work the Doppler log was needed for navigational purposes, but it was switched off when the ship was underway.

Navigation and heading information were recorded together with the velocities. Both ADCPs used the synchro version of the Fiber Optic Compass (FOG) heading connected directly to the chassis of the ADCP to transform the measured velocities into earth coordinates although it has been found on an earlier cruise (M47/1) that the FOG has a heading dependent error. Because of this error the data were corrected by substituting the syncro-FOG heading values of each single ping with heading values from the Ashtech receiver. The Ashtech receiver operated continuously throughout the cruise, delivering reliable heading data.

A water-track calibration of the angle between the transducers and the Ashtech antenna system has been carried out for both instruments. For the 38 kHz OS a misalignment angle of -1.03° and an amplitude factor of 1.004 were determined. For the 75 kHz OS the calibration resulted in a misalignment angle of -1.27° and an amplitude factor of 1.008, which is very close to the calibration carried out during Meteor cruise M62/1.

The range of the 75 kHz OS was of about 700 m, and the 38 kHz OS achieved ranges of 1200 to 1400 m. The sea state was generally calm throughout the cruise and most of the time the ship didn't had to steam against the waves which resulted in a very good quality of shipboard ADCP data for this cruise.

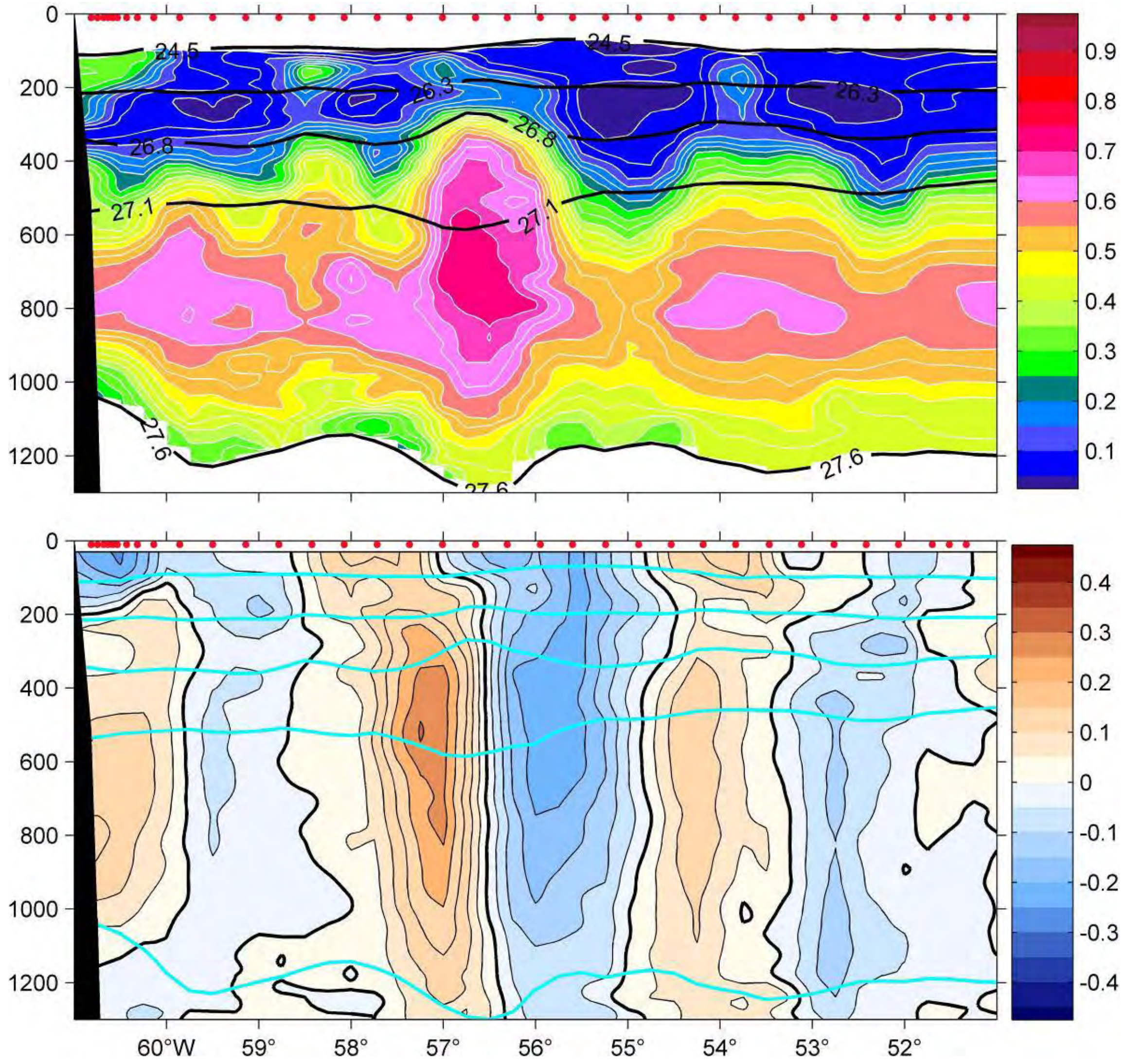


FIG. 1.7: Upper panel: distribution of SAW fraction at 16°N during M66/1. Lower panel: meridonal velocity component from shipboard ADCP measurement. The conspicuous feature centred at about 56°W is a North Brazil Current ring, transporting SAW to the north, especially in the Intermediate Water and the lower central water range. The black and blue lines are isopycnals, used to separate the water masses. The NBC rings seem to be a frequent feature at 16°N and we observed these rings on all our cruises.

1.4.5 Preliminary Results From the Bremen Moored CARIBA Array

(C. Mertens)

The Bremen CARIBA array consists of 2 Inverted echo sounders with bottom pressure sensors (PIES) which have been deployed for 2 years. The southernmost instrument was located north of Tobago and the northern instrument east of St. Lucia, both in about 1000m depth (Table 1, more details see Table 3). The PIES encompass the major inflow paths of South Atlantic Water (SAW) into the Caribbean and thus measure the integral transport through Grenada passage as well as St. Vincent passage. The acoustic travel time measured by the PIES were converted into T/S profiles, using our shipboard CTD measurements and the moored Microcats, which were deployed near the PIES and additionally south of Barbados (Table 1).

TAB. 1.1: CARIBA Moorings on cruise M66/1.

Name	Latitude	Longitude	Depth	Deployment Date	Retrieval
B8	11°21.70‘N	60°24.00‘W	1130m	17.7.2004, 14:48	**4.9.2005**
PIES75	11°21.70‘N	60°23.60‘W	1123m	17.7.2004, 15:15	**4.9.2005**
B9	13°01.60‘N	59°47.60‘W	1007m	21.7.2004, 18:57	**2.9.2005**
B10	13°48.00‘N	60°41.50‘W	1002m	22.7.2004, 11:00	**3.9.2005**
PIES56	13°47.50‘N	60°41.80‘W	993m	22.7.2004, 13:50	**6.9.2005**

PIES: Inverted Echo Sounder with Pressure sensor Time in UTC
Bold dates: work done during M66/1 cruise

Both time series show an increase in the SAW fraction by about 10-20%, especially in the Intermediate Water and the lower central water (Fig.1.9). Since the total transport did not change, the transport of SAW into the Caribbean did increase within these tow years.

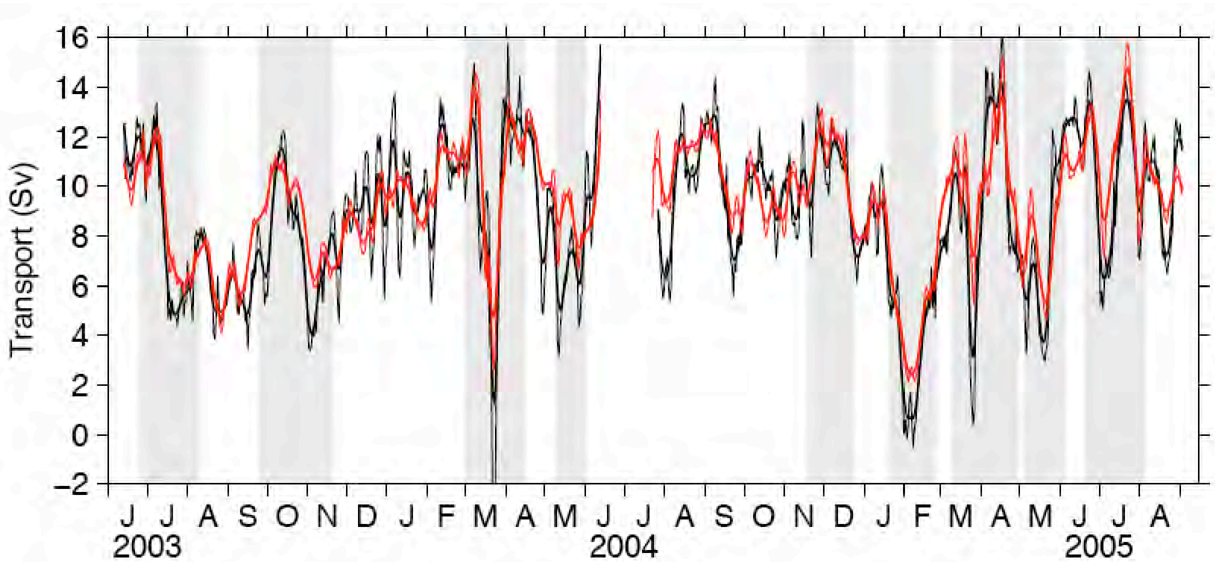


FIG. 1.8 Two-year transport time series of SAW into the Caribbean through Grenada and St. Vincent passage, inferred from the PIES. Positive: inflow into the Caribbean. The gray shaded areas denote periods of elevated energy: black: total transport, the transport relative to 1000nm is red. From Mertens et al., 2008.

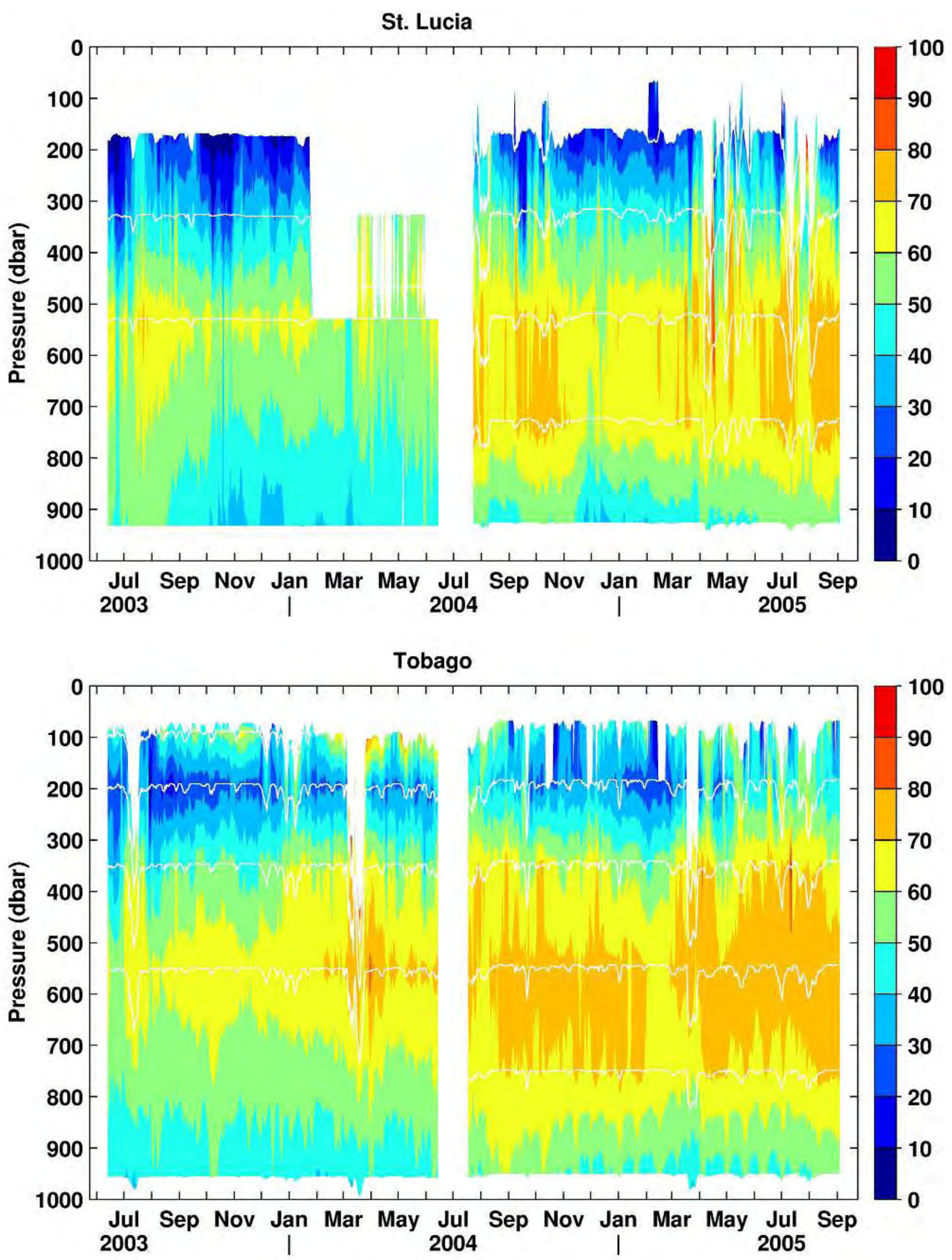


FIG. 1.9: Fraction of South Atlantic Water (SAW) at St. Lucia (upper figure) and Tobago (lower figure), Inferred from the T/S data of the Microcats. The depth of the Microcats are shown by the white lines. The data gap at St. Lucia in the first year was caused by a loss of the top buoy by fishing activities.

1.4.6 Sampling of Henry Seamount

(Andreas Klügel, Thor H. Hansteen)

Henry Seamount, an 8-km wide and 660-m tall volcano rising from 3700 m deep seafloor southeast of El Hierro (Fig. 1.10), was sampled by six dredge hauls:

TAB. 1.2 Dredge stations during M66/1

Date	Station	Dredge type	*on bottom:* Latitude	Longitude	Depth	*off bottom*: Latitude	Longitude	Depth
14.8.05	392	Chain bag	27°18,50N	17°47,01W	3460	27°18,71N	17°46,78W	3330
14.8.05	393	Chain bag	27°18,89N	17°46,78W	3270	27°19,32N	17°46,62W	3160
14.8.05	394	Chain bag	27°17,82N	17°45,05W	3600	27°18,26N	17°45,07W	3350
14.8.05	395	Drum	27°17,97N	17°45,18W	3500	27°18,62N	17°44,78W	3410
14.8.05	396	Drum	27°19,80N	17°47,75W	3540	27°20,17N	17°47,49W	3380
14.8.05	397	Drum	27°19,85N	17°45,92W	3050	27°20,39N	17°45,96W	3160

Overall, dredging bites were extremely scarce confirming the previously inferred meter-thick sediment coverage (Gee et al., 2001). Only the drum dredge recovered hard rocks but all dredge hauls yielded soft silty to sandy sediment. The southern slopes of Henry Seamount apparently show thicker sediment coverage than the steeper northern slopes, which may be the result of deep-sea currents from northern directions. The dredged samples include:

- Trachytic rock fragments and pebbles with few phenocrysts (plagioclase, amphibole, titanite). The samples range from fresh to strongly altered and are covered by thin Mn-crust.
- Vesicular fragment of glassy basalt.
- Volcaniclastic sandstones with abundant Globigerina foraminifers.
- Fragments of cm-thick layered Mn-crusts.
- Fresh porous fragment of almost pure barite underlying a deep-sea coral stem (Fig. 1.10).
- Small fragments of porous biogenic or abiogenic carbonates.
- Abundant shell fragments of vesicomyid clams up to 15 cm in size that are mildly corroded (Fig. 1.11)).

The presence of shells from vesicomyid clams is surprising since this species is always associated with active hydrothermal vents or seep areas. To our knowledge, this is the first reported finding of vesicomyid clams and also the first direct or indirect evidence of submarine venting activity within the Canary Archipelago. Their preservation state suggests that the shells are not very old, probably less than 100.000 years. Texture, porosity and extreme freshness of a barite fragment recovered from the summit plateau also indicate a recent origin. The fragment is considerably larger than other marine or diagenetic barites suggesting that it originated by some focussed fluid flow.

As a preliminary interpretation, Henry Seamount may represent a recently active volcanic system related to the present location of the hotspot near El Hierro. This would be supported by the small degree of alteration of the freshest dredged trachytes. Alternatively and more likely, fluid discharge at the seamount may be related to seawater recharge at the neighbouring island of El Hierro followed by lateral flow and heating in the warm and permeable crust (Harris et al., 2004). But how can recent venting be reconciled with the presence of some meters of sediment drape? Does Henry Seamount currently show some kind of rejuvenated activity? Geochemical investigations and age determinations of rocks and shells will be carried out to resolve these questions.

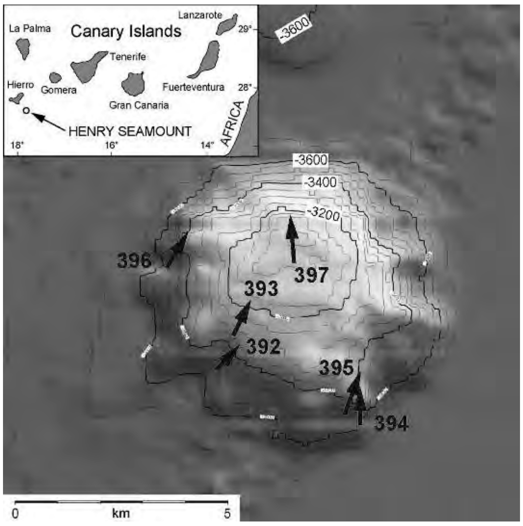


FIG. 1.10: Detailed bathymetric map (50 m contours) of Henry Seamount.

FIG. 1.11: Fresh barite fragment with coral stem (left) and shell of vesicomyid clam (right).

1.5 Ship's Meteorological Station

(C. Kreutzmann)

First section from Las Palmas de Gran Canaria (Spain, August 13th) to Hierro (Spain, August 15th)

Weather was dominated by the subtropical high west of Bay of Biscay with a ridge to the southeastern Azores and a later connection to a new predominant high to the southsouthwest of Azores. The dynamic counterpart was a heat low near Mauritania, shifting to South-Algeria with a trough to Portugal. In between METEOR was under strengthening gradient of atmospheric pressure with persistent north to northeasterly trade wind and corresponding sea (increasing from Bft 5, sea 1.5m to Bft 6, sea 2.5m). It was modified by local effects near Canary Islands, so plus Bft 1 in the nozzles between islands, veering wind around Bft 3 in the lee as well as northerly Bft 7 with gusts up to Bft 11 and rough sea around 3m close southeast to steep coast of Hierro. Water temperature was about 22 to 23°C.

Transit to 15.2°N 51.2°W until August 22th

The strengthening subtropical high shifted northeast to the outer Bay of Biscay with later return to the Azores. A ridge of high pressure turned to northwest from 20°N 40°W to Florida. The cruise area was along its south-eastern side in the regular trade wind, starting with north-north-easterly Bft 6 at August 15th, abating to east-north-easterly Bft 4 until August 19th and then veering to east-southeast. Sea started with 2.5m from north-northeast and finished with 1 to 1.5m from easterly direction. A weak easterly wave left Senegal at August 16th. Fringes of an upper level low entered the cruise area with freshening wind and scattered showers in the early August 19th. From then there was some tendency to local trade wind showers in the course of the following days. The easterly wave reached METEOR at August 22th. During the transit there was a rise in water temperature from 23 to 28°C. The ITCZ was continued to lying between 9 and 12°N.

Section to 16.3°N 60.8°W until August 29th

The steering subtropical high near Azores weakened along its way to 31°N 40°W. The ridge to the Bahamas did the same and was replaced by a connection to a new high southeast of Nova Scotia from August 27th on. Weather conditions around METEOR was made by a second ridge, slowly shifting from 15°N 47°W to METEOR at August 24th and farther to the Greater Antilles. Firstly wind blew with moderate force (Bft 4 to 5) from the east and decreased down to variable Bft 3 in the course of the section with temporary backing to northeast at August 26th and later veering to southeast. From August 24th some weak and scattered showers with gusts up to Bft 5, poor visibility and cooling down to 25°C occurred in the ship environment on the back side of the second ridge. Swell up to 2m veered from east to northeast with a decrease down to 1 - 1.5m. Water temperature showed further warming nearly up to 30°C. Tropical waves remained east of the cruise area, one weak system with embedded cyclonic circulation (close upper level trough prevented stronger development) approached METEOR up to 200 nm until August 29th. Branches of the ITCZ were situated far away between 9 and 11°N with decay from August 25th.

Section between Guadeloupe (France), St. Lucia (France), Barbados and Tobago until September 4th

The centres of subtropical high southeast of Newfoundland and southwest of Azores united to one extensive core close to the northwest of Azores. METEOR sailed along its southern flank with a regular change of easterly waves and weak ridges - in each case with an north-south axis. First easterly wave crossed the cruise area early in the August 29th with showers and gusts up to Bft 5. At August 30th the formerly Tropical Depression No.13 passed north of the cruise area, the accessory trough stretched out to Tobago and touched METEOR with showery gusts up to Bft 7. The Tropical Depression No.14 was also leaded by subtropical high and was upgraded to Tropical Storm MARIA north of METEOR at September 2nd (further upgrade to Hurricane No.5 near 28°N 55°W at September 4th). Only its trough reached far to the south and at September 1st a separated and westward moving cloud cluster nearby a 15°N ITCZ-branch touched the cruise area with showers, gusts to Bft 7 and temporary poor visibility. Completely dry conditions without any trade shower activity you could only expect directly in front of and under a strong ridge of high pressure. Variable south-easterly winds around Bft 3 turned to eastnortheast from August 30th on and showed a temporary rise up to Bft 5 during night to September 1st. The swell came always from east to northeast with about 1.5m and a maximum of 2.5m at September 1st. Water temperature was between 29 and 30°C.

Section from Tobago along Windward and Leeward Islands to Anegada (British Virgin Islands) until September 12th

Subtropical high started northwest of Azores and finished the section west of Cape Finisterre. A wide ridge stretched out across eastern Caribbean Sea, shifting northwest to Cuba with following stationarity due to three tropical storms MARIA, NATE and OPHELIA to the north. At September 10th a further high pressure core developed north of METEOR near 27°N 60°W. Until September 12th a steering upper level high close east of low-level high shifted to cruise area and finished shower activity: During this section four easterly tropical disturbances with showers and sheet lightning crossed METEOR, namely in the night to September 6th, daytime at September 6th, in the night to September 9th (with frontal upper-level low and following ITCZ-cluster) and finally at September 11th with surrounding cloud of Saharan dust. Easterly trade winds blew with Bft 3 to 4, in combination with passing waves there were increasing winds up to Bft 5 as well as veering and backing. In lee of the islands you found calm regions. Southern nozzles showed no increasing winds due to the weak mean wind of about Bft 3. Nozzle-effects of plus Bft 1 were found only under more windy conditions in the Guadeloupe- and Anegada-Passages with further increases in its southern parts parallel to the steep coasts. Gusts up to Bft 7 occurred during passages of first three waves. From September 6th branches of ITCZ moved up to 15°N in connection with crossing waves. Sea around 1.5m came from northeast to east with maximum up to 3m in connection with swell of Ex-Hurricane MARIA during night to September 10th. Water temperature was unchanged near 30°C.

Section to 23.6°N 64.2°W until September 16th

First, an upper level high crossed cruise area with dry air masses and very good visibility, wind blew with Bft 3 to 4 from northeast to east with sea of about 1.5m. Simultaneously a strong stationary cyclone developed across Central Atlantic southeast of Newfoundland. A huge trough on its back moved unusually far to the south down to Puerto Rico and divided low level subtropical high into one part across southeastern North Atlantic and a second part between Bermudas and Gulf of Mexico. From September 14th METEOR approached low level trough with following passing cold upper level trough with strong vertical wind shear. Direction of low level trade winds was further predominated by the north-western subtropical high. Wind from easterly directions subsequently increased up to Bft 5 to 6 until September 15th, at the same time sea state was rougher with wave heights up to 3m from northeast. There were cloudy skies, heavy showers and thunderstorms with gusts up to Bft 9 as well as partly poor visibility. Water temperature declined a little to 29°C.

Transit to Willemstad/Curacao (Netherlands) until September 19th

Until early September 17th cruise area remained nearby an upper-level low at 23°N 66°W with easterly Bft 4 to 6, thunder showers, gusts to Bft 9 and wave heights around 2.5m. During further transit METEOR sailed into more dry conditions between subtropical high to the north between Gulf of Mexico as well as northeast of Bermudas and low pressure across the south-western Caribbean Sea. Easterly to south-easterly trade winds of around Bft 4 brought a weak tropical wave to the cruise area until September 18th. Wave heights decrease to 1.5m, Water temperature reached again 30°C.

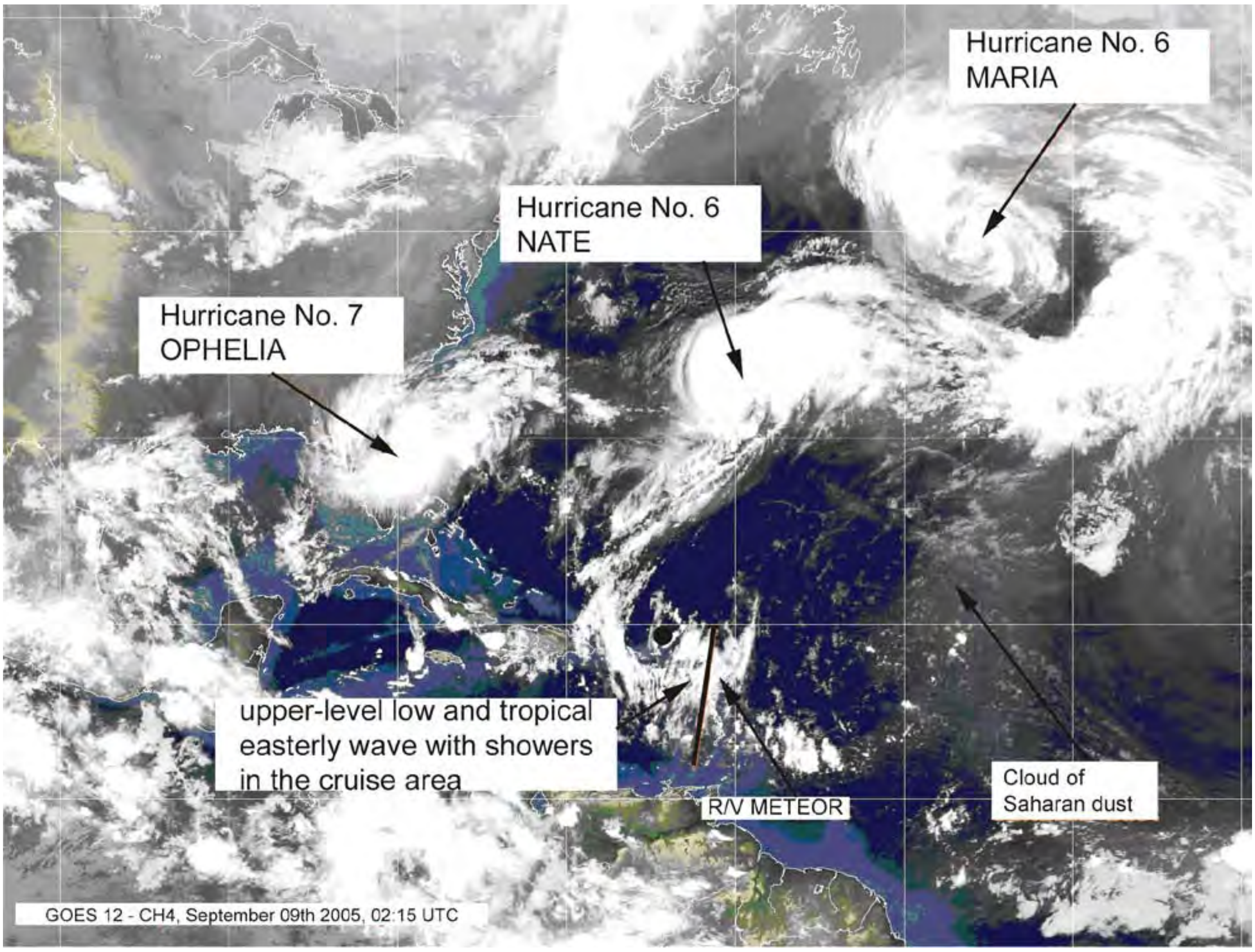


FIG. 1.12: Meteorological conditions at September 9, 02:15 UTC.

1.6 List of Stations

List of moored instruments

TAB. 1.3: Recovered CARIBA Mooring B8/Tobago.

Instrument	Number	Depth	Comments
Releaser	AR517	1055m	
Releaser	AR798	1055m	
MicroCat C,T	2476	953m	
MicroCat C,T	2454	753m	
MicroCat C,T	2438	552m	
RCM11	93	350m	
MicroCat C,T	2377	352m	
MicroCat C,T	2277	195m	
RCM11	91	93m	
MicroCat C,T	2051	78m	

Sampling rate for all instruments : 30min.
RCM: Anderaa Acoustic Current Meter, +P: with pressure sensor
MicroCat C,T : SBE, measurement of temperature and conductivity
no radio transmitter, no flashlight

TAB. 1.4: Recovered CARIBA Mooring B9/Barbados.

Instrument	Number	Depth	Comments
Releaser	RT520	985m	
Releaser	RT521	985m	
MicroCat C,T	2050	952m	
MicroCat C,T	1943	751m	
MicroCat C,T	1931	550m	
RCM11	89	449m	
MicroCat C,T	1933	342m	
MicroCat C,T	1915	193m	
RCM11	94	90m	no data
MicroCat C,T	1888	73m	

RCM: Anderaa Acoustic Current Meter, +P: with pressure sensor
MicroCat C,T : SBE, measurement of temperature and conductivity
no radio transmitter, no flashlight

TAB. 1.5: Recovered CARIBA Mooring B10 / St. Lucia.

Instrument	Number	Depth	Comments
Releaser	RT531	955m	
Releaser	AR810	955m	
MicroCat C,T	3199	949m	
MicroCat C,T	3198	748m	
MicroCat C,T	3197	547m	
MicroCat C,T	1936	346m	
RCM11	92	344m	
MicroCat C,T	1934	189m	
RCM11	95	87m	
MicroCat C,T	1932	71m	

Sampling rate for all instruments : 30min.
RCM: Anderaa Acoustic Current Meter, +P: with pressure sensor
MicroCat C,T : SBE, measurement of temperature and conductivity
Radio frequency: 160.785 MHz

Lists of CTD/ LADCP stations

Prof: Profile, Sta: station, Water depth and Profile depth in m, CFCs: chlorofluorocarbons, LADCP: Lowere Acoustic Doppler Current Profiler, Time in UTC.

Meteor M66/1		**CTD Stations**						**Page 1**		
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
1	398	2005/08/17	16:30	23° 36.78' N	28° 59.49' W	5601	2001		x	
2	399	2005/08/20	15:01	18° 27.59' N	42° 53.82' W	4748	2503	x	x	
3	400	2005/08/21	16:03	16° 45.80' N	47° 22.65' W	4081	2472	x	x	
4	401	2005/08/22	15:11	15° 14.49' N	51° 20.04' W	3998	3961	x	x	
5	402	2005/08/22	19:12	15° 16.01' N	51° 31.09' W	5251	5270	x	x	
6	403	2005/08/23	00:01	15° 17.04' N	51° 41.96' W	5421	5427	x	x	
7	404	2005/08/23	05:49	15° 19.00' N	52° 4.04' W	4960	4961	x	x	
8	405	2005/08/23	11:03	15° 21.98' N	52° 25.10' W	5150	5161	x	x	
9	406	2005/08/23	16:07	15° 23.99' N	52° 46.01' W	5150	5148	x	x	
10	407	2005/08/23	20:59	15° 26.46' N	53° 7.14' W	5310	5303	x	x	
11	408	2005/08/24	02:07	15° 29.03' N	53° 28.04' W	5413	5420	x	x	
12	409	2005/08/24	07:29	15° 31.51' N	53° 50.02' W	5475	5477	x	x	
13	410	2005/08/24	12:37	15° 33.97' N	54° 11.01' W	5452	5462	x	x	
14	412	2005/08/24	18:26	15° 36.51' N	54° 31.87' W	5496	5499	x	x	
15	413	2005/08/24	23:42	15° 38.84' N	54° 53.02' W	5489	5500	x	x	
16	414	2005/08/25	05:08	15° 41.51' N	55° 14.47' W	5487	5496	x	x	
17	415	2005/08/25	10:20	15° 43.91' N	55° 36.09' W	5484	5497	x	x	
18	416	2005/08/25	15:41	15° 46.47' N	55° 57.05' W	5591	5466	x	x	
19	418	2005/08/25	21:03	15° 48.98' N	56° 18.50' W	5333	5335	x	x	
20	419	2005/08/26	02:12	15° 51.48' N	56° 39.03' W	5287	5290	x	x	
21	420	2005/08/26	07:34	15° 53.95' N	57° 0.54' W	5184	5177	x	x	
22	421	2005/08/26	12:37	15° 56.51' N	57° 22.03' W	5286	5304		x	
23	423	2005/08/26	18:15	15° 59.08' N	57° 43.00' W	5379	5414	x	x	
24	424	2005/08/26	23:23	16° 1.53' N	58° 4.56' W	5364	5379	x	x	
25	425	2005/08/27	04:36	16° 4.05' N	58° 25.55' W	5590	5606	x	x	
26	426	2005/08/27	09:54	16° 6.48' N	58° 47.07' W	5760	5780	x	x	
27	427	2005/08/27	15:24	16° 9.03' N	59° 8.54' W	5328	5353	x	x	
28	428	2005/08/27	20:23	16° 11.46' N	59° 30.07' W	4995	4992	x	x	
29	429	2005/08/28	01:14	16° 12.95' N	59° 51.51' W	5031	5018	x	x	
30	430	2005/08/28	05:53	16° 13.01' N	60° 8.45' W	4844	4836		x	
31	431	2005/08/28	09:50	16° 14.43' N	60° 18.97' W	4460	4449	x	x	
32	432	2005/08/28	13:24	16° 15.88' N	60° 25.97' W	4778	4769		x	
33	433	2005/08/28	17:08	16° 16.51' N	60° 31.97' W	4359	4363	x	x	
34	434	2005/08/28	20:15	16° 16.95' N	60° 35.02' W	3060	3068		x	
35	435	2005/08/28	22:52	16° 17.45' N	60° 37.99' W	2540	2482	x	x	
36	436	2005/08/29	01:00	16° 17.53' N	60° 40.98' W	1742	1520	x	x	

Meteor M66/1			**CTD Stations**					**Page 2**		
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
37	437	2005/08/29	02:49	16° 17.55' N	60° 44.98' W	1100	780	x	x	
38	438	2005/08/29	04:16	16° 17.45' N	60° 49.00' W	549	539	x	x	
39	439	2005/08/29	05:59	16° 7.97' N	60° 45.03' W	1019	1049		x	
40	440	2005/08/29	07:51	15° 58.56' N	60° 44.55' W	995	985		x	
41	441	2005/08/29	09:37	15° 48.99' N	60° 44.55' W	1652	1634	x	x	
42	442	2005/08/29	11:48	15° 39.57' N	60° 43.99' W	2227	2201	x	x	
43	443	2005/08/29	14:20	15° 30.47' N	60° 44.09' W	2519	2491		x	
44	444	2005/08/29	17:15	15° 20.95' N	60° 43.56' W	2012	1992		x	
45	445	2005/08/29	19:37	15° 11.89' N	60° 43.55' W	1770	1758		x	
46	446	2005/08/29	21:49	15° 2.47' N	60° 43.54' W	917	920		x	
47	447	2005/08/29	23:33	14° 53.03' N	60° 43.04' W	537	532		x	
48	448	2005/08/30	01:02	14° 43.98' N	60° 43.01' W	527	522		x	
49	449	2005/08/30	02:30	14° 34.46' N	60° 42.52' W	631	635	x	x	
50	450	2005/08/30	04:18	14° 25.01' N	60° 42.49' W	1250	1234	x	x	
51	451	2005/08/30	06:23	14° 15.47' N	60° 42.00' W	1435	1415	x	x	
52	452	2005/08/30	08:22	14° 6.52' N	60° 42.04' W	1033	1021	x	x	
53	453	2005/08/30	10:11	13° 57.02' N	60° 42.01' W	974	957	x	x	
54	454	2005/08/30	11:54	13° 49.05' N	60° 41.48' W	986	973	x	x	
55	455	2005/08/30	13:50	13° 38.04' N	60° 40.55' W	1247	1227	x	x	
56	456	2005/08/30	15:50	13° 28.94' N	60° 38.96' W	1658	1635	x	x	
57	457	2005/08/30	18:03	13° 19.95' N	60° 38.03' W	1899	1872	x	x	
58	458	2005/08/30	20:19	13° 10.99' N	60° 37.00' W	2106	2078	x	x	
59	459	2005/08/30	22:49	13° 1.52' N	60° 36.04' W	2241	2217	x	x	
60	460	2005/08/31	01:27	12° 52.69' N	60° 35.11' W	2360	2335	x	x	
61	461	2005/08/31	04:13	12° 43.56' N	60° 34.06' W	2461	2432	x	x	
62	462	2005/08/31	06:51	12° 34.05' N	60° 33.07' W	2460	2434	x	x	
63	463	2005/08/31	09:30	12° 24.98' N	60° 32.05' W	2437	2411	x	x	
64	464	2005/08/31	12:11	12° 16.02' N	60° 30.59' W	2383	2355		x	
65	465	2005/08/31	14:52	12° 6.53' N	60° 29.59' W	2402	2373	x	x	
66	466	2005/08/31	17:29	11° 57.51' N	60° 28.60' W	2029	2007		x	
67	467	2005/08/31	19:52	11° 48.48' N	60° 27.52' W	1477	1453	x	x	
68	468	2005/08/31	22:03	11° 39.46' N	60° 26.01' W	1214	1193	x	x	
69	469	2005/09/01	00:03	11° 30.02' N	60° 25.06' W	1113	1088	x	x	
70	470	2005/09/01	01:51	11° 23.01' N	60° 24.57' W	1191	1171	x	x	
71	471	2005/09/01	03:37	11° 30.10' N	60° 21.04' W	1415	1388		x	
72	472	2005/09/01	05:44	11° 39.51' N	60° 18.09' W	1457	1392	x	x	

Meteor M66/1			**CTD Stations**					**Page 3**		
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
73	473	2005/09/01	07:49	11° 48.48' N	60° 15.06' W	1596	1571	x	x	
74	474	2005/09/01	10:03	11° 57.98' N	60° 12.03' W	1823	1800	x	x	
75	475	2005/09/01	12:24	12° 6.96' N	60° 9.10' W	2010	1985	x	x	
76	476	2005/09/01	14:48	12° 15.92' N	60° 6.06' W	2205	2183	x	x	
77	477	2005/09/01	17:17	12° 25.55' N	60° 3.03' W	2301	2270	x	x	
78	478	2005/09/01	19:47	12° 34.47' N	60° 0.01' W	2100	2135	x	x	
79	479	2005/09/01	22:19	12° 43.99' N	59° 57.02' W	1930	1901	x	x	
80	480	2005/09/02	00:39	12° 52.96' N	59° 54.07' W	1706	1683	x	x	
81	481	2005/09/02	02:53	13° 1.98' N	59° 49.04' W	1242	1218	x	x	
82	485	2005/09/02	11:50	13° 11.54' N	59° 48.02' W	1087	1064	x	x	
83	486	2005/09/02	13:31	13° 16.49' N	59° 55.53' W	1659	1634	x	x	
84	487	2005/09/02	15:41	13° 21.50' N	60° 3.01' W	1888	1863	x	x	
85	488	2005/09/02	17:56	13° 27.10' N	60° 11.04' W	2088	2064	x	x	
86	489	2005/09/02	20:10	13° 32.07' N	60° 18.52' W	2000	1973	x	x	
87	490	2005/09/02	22:30	13° 37.52' N	60° 26.04' W	1850	1818	x	x	
88	491	2005/09/03	00:46	13° 42.51' N	60° 34.08' W	1396	1377	x	x	
89	492	2005/09/03	02:45	13° 48.53' N	60° 41.54' W	991	980	x	x	
90	493	2005/09/03	04:21	13° 48.50' N	60° 48.97' W	582	469		x	
91	504	2005/09/04	11:33	11° 21.70' N	60° 23.78' W	1112	1101		x	
92	505	2005/09/04	13:20	11° 30.60' N	60° 27.98' W	925	910		x	
93	506	2005/09/04	15:11	11° 40.54' N	60° 31.51' W	1162	1138		x	
94	507	2005/09/04	17:15	11° 50.50' N	60° 35.07' W	1663	1636		x	
95	508	2005/09/04	19:29	12° 0.47' N	60° 39.04' W	2300	2262		x	
96	509	2005/09/04	22:15	12° 10.47' N	60° 42.52' W	2300	2228	x	x	
97	510	2005/09/05	00:58	12° 20.33' N	60° 46.05' W	2311	2283	x	x	
98	511	2005/09/05	03:36	12° 30.56' N	60° 50.06' W	2110	2086	x	x	
99	512	2005/09/05	06:09	12° 40.05' N	60° 53.49' W	1548	1529	x	x	
100	513	2005/09/05	08:20	12° 49.99' N	60° 57.02' W	1300	1219	x	x	
101	514	2005/09/05	10:20	12° 59.99' N	61° 1.00' W	600	588	x	x	
102	515	2005/09/05	11:50	13° 9.98' N	61° 4.03' W	437	438		x	
103	517	2005/09/05	13:37	13° 23.41' N	61° 5.60' W	483	498	x	x	
104	518	2005/09/05	14:30	13° 25.14' N	61° 4.43' W	1005	994	x	x	
105	519	2005/09/05	15:50	13° 28.04' N	61° 2.36' W	869	852	x	x	
106	520	2005/09/05	17:07	13° 30.78' N	61° 0.38' W	351	348	x	x	
107	521	2005/09/05	18:00	13° 33.06' N	60° 58.84' W	333	324	x	x	
108	522	2005/09/05	19:11	13° 36.75' N	60° 56.02' W	373	360		x	

Meteor M66/1			**CTD Stations**					**Page 4**		
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
109	531	2005/09/06	12:26	14° 10.81' N	60° 54.14' W	415	419		x	
110	532	2005/09/06	13:16	14° 13.08' N	60° 53.77' W	780	777	x	x	
111	533	2005/09/06	14:18	14° 15.70' N	60° 53.30' W	902	897	x	x	
112	534	2005/09/06	15:31	14° 18.99' N	60° 52.75' W	878	840	x	x	
113	535	2005/09/06	16:42	14° 21.71' N	60° 52.35' W	329	330	x	x	
114	544	2005/09/07	07:24	14° 56.76' N	61° 9.07' W	413	420		x	
115	545	2005/09/07	08:22	14° 59.97' N	61° 10.68' W	631	594	x	x	
116	546	2005/09/07	09:28	15° 3.39' N	61° 12.42' W	1460	1422	x	x	
117	547	2005/09/07	11:07	15° 5.91' N	61° 13.71' W	2057	2043	x	x	
118	548	2005/09/07	13:05	15° 9.06' N	61° 15.26' W	1464	1456	x		
119	549	2005/09/07	14:33	15° 11.13' N	61° 16.77' W	856	844	x	x	
120	551	2005/09/07	16:34	14° 59.94' N	61° 22.98' W	2369	2354		x	
121	552	2005/09/07	23:04	15° 41.32' N	61° 28.43' W	788	866	x	x	
122	553	2005/09/08	00:14	15° 42.08' N	61° 27.39' W	1084	1071	x	x	
123	554	2005/09/08	01:40	15° 44.77' N	61° 28.43' W	707	631	x	x	
124	555	2005/09/08	02:45	15° 48.03' N	61° 29.85' W	470	467	x	x	
125	556	2005/09/08	04:42	15° 57.30' N	61° 33.41' W	513	250		x	
126	560	2005/09/08	19:11	16° 17.51' N	60° 41.03' W	1737	1704	x	x	
127	563	2005/09/08	20:55	16° 17.51' N	60° 38.03' W	2480	2504		x	
128	562	2005/09/08	23:18	16° 17.01' N	60° 35.11' W	3165	3120	x	x	
129	563	2005/09/09	02:00	16° 16.53' N	60° 32.09' W	4305	4334		x	
130	564	2005/09/09	05:50	16° 16.00' N	60° 26.07' W	4771	4765	x	x	
131	565	2005/09/09	10:03	16° 14.49' N	60° 19.02' W	4459	4449		x	
132	566	2005/09/09	14:56	16° 17.00' N	60° 35.09' W	3152	3101		x	Yo-Yo
133	566	2005/09/09	16:55	16° 16.98' N	60° 34.98' W	3358	3093		x	Yo-Yo
134	566	2005/09/09	18:48	16° 16.98' N	60° 34.98' W	3124	3073		x	Yo-Yo
135	566	2005/09/09	20:59	16° 16.99' N	60° 35.02' W	3134	3075		x	Yo-Yo
136	566	2005/09/09	23:07	16° 16.99' N	60° 35.01' W	3138	3088		x	Yo-Yo
137	566	2005/09/10	01:12	16° 17.00' N	60° 34.98' W	3138	3097		x	Yo-Yo
138	567	2005/09/10	08:22	16° 32.94' N	61° 30.50' W	458	453	x	x	
139	569	2005/09/10	09:24	16° 36.48' N	61° 32.02' W	433	431		x	
140	570	2005/09/10	10:22	16° 39.98' N	61° 33.53' W	417	411	x	x	
141	571	2005/09/10	11:50	16° 43.33' N	61° 35.06' W	190	674	x	x	
142	572	2005/09/10	12:54	16° 46.90' N	61° 36.54' W	853	844	x	x	
143	573	2005/09/10	14:03	16° 50.43' N	61° 38.09' W	427	421		x	
144	574	2005/09/10	14:58	16° 53.92' N	61° 39.54' W	478	466		x	

Meteor M66/1 **CTD Stations** **Page 5**

Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
145	575	2005/09/10	15:48	16° 54.91' N	61° 39.02' W	418	412		x	
146	582	2005/09/11	08:56	18° 15.00' N	63° 21.04' W	438	433		x	
147	583	2005/09/11	09:50	18° 16.02' N	63° 23.51' W	852	844		x	
148	584	2005/09/11	11:05	18° 18.53' N	63° 27.03' W	901	891		x	
149	585	2005/09/11	12:18	18° 20.11' N	63° 30.48' W	1001	987		x	
150	586	2005/09/11	13:35	18° 21.56' N	63° 34.00' W	1064	1052		x	
151	587	2005/09/11	14:50	18° 23.01' N	63° 37.51' W	1136	1124		x	
152	588	2005/09/11	16:19	18° 24.52' N	63° 40.97' W	863	857		x	
153	589	2005/09/11	17:33	18° 26.05' N	63° 44.57' W	709	617		x	
154	590	2005/09/11	18:41	18° 27.43' N	63° 47.97' W	995	1390		x	
155	591	2005/09/11	20:12	18° 28.98' N	63° 51.56' W	1436	1420		x	
156	592	2005/09/11	21:47	18° 30.45' N	63° 55.04' W	1559	1563	x	x	
157	593	2005/09/11	23:26	18° 31.95' N	63° 58.49' W	2191	2173	x	x	
158	594	2005/09/12	01:21	18° 32.88' N	64° 0.01' W	2072	2072		x	
159	595	2005/09/12	03:16	18° 34.03' N	64° 2.07' W	1458	1492	x	x	
160	596	2005/09/12	04:57	18° 34.44' N	64° 3.99' W	1921	1916		x	
161	597	2005/09/12	07:00	18° 35.47' N	64° 6.52' W	1168	1157	x	x	
162	598	2005/09/12	08:16	18° 36.50' N	64° 8.04' W	416	412		x	
163	601	2005/09/12	19:04	18° 47.49' N	64° 20.02' W	622	607		x	
164	602	2005/09/12	20:03	18° 50.00' N	64° 20.02' W	1312	1292	x	x	
165	603	2005/09/12	21:29	18° 52.98' N	64° 20.03' W	1858	1841	x	x	
166	604	2005/09/12	23:26	18° 58.40' N	64° 20.04' W	2926	2905	x	x	
167	605	2005/09/13	02:10	19° 3.42' N	64° 20.04' W	3832	3812	x	x	
168	606	2005/09/13	05:39	19° 8.94' N	64° 19.54' W	4851	4865	x	x	
169	607	2005/09/13	09:46	19° 13.95' N	64° 19.02' W	5256	5280	x	x	
170	608	2005/09/13	14:07	19° 23.93' N	64° 18.02' W	5390	5473	x		
171	609	2005/09/13	19:36	19° 41.46' N	64° 17.02' W	6938	5700	x		
172	610	2005/09/14	01:45	20° 3.92' N	64° 15.52' W	5998	5701	x		
173	611	2005/09/14	08:03	20° 26.01' N	64° 14.53' W	4960	4967	x		
174	612	2005/09/14	13:16	20° 48.49' N	64° 13.06' W	5146	5155	x		
175	613	2005/09/14	18:51	21° 10.62' N	64° 11.43' W	5339	5355	x		
176	614	2005/09/15	00:23	21° 32.47' N	64° 10.51' W	5574	5602	x		
177	615	2005/09/15	06:11	21° 52.52' N	64° 10.06' W	5741	5691	x		
178	616	2005/09/15	12:13	22° 16.90' N	64° 9.09' W	5791	5701	x		
179	617	2005/09/15	18:23	22° 42.04' N	64° 8.02' W	5806	5686	x		
180	618	2005/09/16	00:25	23° 6.92' N	64° 7.01' W	5803	5695	x		
181	619	2005/09/16	07:20	23° 36.48' N	64° 6.09' W	5805	5688	x		

1.7 References

Gee, M.J.R., D.G. Masson, A.B. Watts, and N.C. Mitchell, 2001. Offshore continuation of volcanic rift zones, El Hierro, Canary Islands. Journal of Volcanology and Geothermal Research, 105, 107-119

Harris, R.N., A.T. Fisher, and D.S. Chapman, 2004. Fluid flow through seamounts and implications for global mass fluxes. Geology, 32, 725-728

Kirchner, K., M. Rhein, C. Mertens, C. W. Böning, and S. Hüttl, 2008. Observed and modeled MOC related flow into the Caribbean. Journal of Geophysical Research, 113, C03028

Mertens, C., M. Rhein, K. Kirchner, and M. Walter, 2008. Modulation of the Inflow into the Caribbean Sea by North Brazil Current Rings. Deep-Sea Research Part I, submitted

Rhein, M., M. Walter, C. Mertens, R. Steinfeldt, and D. Kieke, 2004. Circulation of North Atlantic Deep Water at 16°N, 2000-2003. Geophysical Research. Letters, 31, LI4305

Rhein, M., K. Kirchner, C. Mertens, R. Steinfeldt, M. Walter and U. Fleischmann-Wischnath, 2005. The transport of South Atlantic Water through the Passages south of Guadeloupe and across 16°N, 2000-2004. Deep Sea Research Part I, 52, 2234-2249

CCHDO Data Processing Notes

Date	Person	Data Type	Action	Summary
2011-11-18	*Carolina Berys*	CTD/BTL/SUM	Website Updated	Available under 'Files as received'

Detailed Notes

Files M661.SEA (containing bottle data), m661_ctd.zip
M661.SUM (SUM file), shortcruisem661.pdf (Cruise Report), submitted by
Reiner Steinfeldt on 2011-11-17, available under 'Files as received',
unprocessed by CCHDO.

Date	Person	Data Type	Action	Summary
2012-08-24	*Bob Key*	BTL/SUM	Submitted	update, to go online

Detailed Notes

I reformatted the SUN and SEA files you previously received from Steinfeldt to EXCHANGE. Once the CTD data has been reformatted to Exchange, I can add CTDOXY to the bottle file. I also did minor QC. It is possible that the metadata in the header might change a bit. If so, I'll reprint.

Date	Person	Data Type	Action	Summary
2012-08-27	*Bob Key*	BTL	Submitted	update, to go online

Detailed Notes

Identical to recent submission except for updates to the header lines

Date	Person	Data Type	Action	Summary
2012-08-28	*Bob Key*	BTL/CrsRpt	Submitted	final ctd oxy

Detailed Notes

Sorry for not getting everything done at once. This version has the CTDOXY values interpolated from the Exchange format CTD files you recently posted. So far as I know, this leg is now finished. I"ve also uploaded a copy of the full cruise report for Met66 (legs 1-4)

Date	Person	Data Type	Action	Summary
2012-08-28	*CCHDO Staff*	BTL/CrsRpt	Website Update	Available under 'Files as received'

Detailed Notes

The following files are now available online under 'Files as received', unprocessed by the CCHDO.

06MT20050813.exc.csv
M66_final.pdf

Date	Person	Data Type	Action	Summary
2012-08-28	*Matthew Shen*	CTD	Website Update	Exchange, NetCDF, WOCE files online

Detailed Notes

2012-08-24
AR04 2005 ExpoCode 06MT20050813 processing notes - CTD
myshen

SUBMISSION
M661.SEA submitted by Reiner Steinfeldt on 2011-11-17
m661_ctd.zip submitted by Reiner Steinfeldt on 2011-11-17 containing
CTD data processed and online.

The file contains the following parameters (* with flag column):
CTDPRS*
CTDTMP*
CTDSAL*
CTDOXY*

The following changes were made to the original SUM file:
* Changed station 399 cast 2 to cast 1
* Renamed to AR04_06MT20050813su.txt

The following changes were made to the original CTD files:
* Removed records with all NaNs except for CTDPRS from06MT66-1S551C001.ctd (515

records from CTDPRS 125 to 639 inclusive)
* Renamed to AR04_06MT20050813ct.zip

FORMATTED FILE
Exchange CTD file created using libcchdo.
NetCDF CTD file created using exctd_to_netcdf.pl (S. Diggs).
Exchange opened in JOA and ODV with no apparent problems.

Working directory:
/data/co2clivar/atlantic/ar04/ar04_06MT20050813/original/2012.08.23_ctd_myshen

2012-08-29	*Matthew Shen*	BTL/SUM	Website Update	Exchange, NetCDF, WOCE files online

Detailed Notes
2012-08-29
AR04 2005 ExpoCode 06MT20050813 processing notes - BTL
M Shen

SUBMISSION
06MT20050813.exc.csv submitted by Robert M. Key on 2012-08-28 containing bottle data processed and online.
M661.SEA submitted by Reiner Steinfeldt on 2011-11-17 containing bottle data. Used by Robert Key to create 06MT20050813.exc.csv with CTDOXY added. Omitted in favor of generated WOCE bottle file from Exchange with CTDOXY included.

The file contains the following parameters (* with flag column):
CTDPRS
CTDTMP
CTDSAL*
SALNTY*
CTDOXY*
OXYGEN*
CFC-11*
CFC-12*
THETA

The following changes were made to the submission file:
* Reordered rows for each station by non-decreasing CTDPRS.

FORMATTED FILE
* NetCDF bottle file created using exbot_to_netcdf.pl (S Diggs)
* WOCE bottle file created using exchange_to_wocebot.rb (J Fields) and header copied in from M661.SEA. Added METERS as DEPTH unit to get script to run.
* Exchange and NetCDF files opened in JOA with no apparent problems

working directory
/data/co2clivar/atlantic/ar04/ar04_06MT20050813/original/2012.08.28_bot_myshen

2013-01-31	*Jerry Kappa*	CrsRpt	Website Update	Final PDF version online

I've placed 1 new version of the cruise report:

AR04_06MT20050813do.pdf

into the directory: co2clivar/atlantic/ar04/ar04_06MT20050813/

It includes summary pages and CCHDO data processing notes as well as a linked Table of Contents and links to figures, tables and appendices.

It will be available on the cchdo website following the next update script run.